DOCUMENT RESUME

ED 342 635 SE 052 323

AUTHOR Navarro, C. F.
TITLE Early Geometry: A Visual, Intuitive Introduction to Plane Geometry for Elementary School Children.
REPORT NO ISBN-1-878396-04-8
PUB DATE 90
NOTE 68p.
AVAILABLE FROM Start Smart Books, P.O. Box 3446, Alexandria, VA 22302.
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Cognitive Processes; *Concept Formation; Elementary Education; Elementary School Mathematics; *Geometric Concepts; Learning Activities; Mathematics Curriculum; Mathematics Education; *Mathematics Instruction; Perception; *Plane Geometry; Teaching Methods; *Visual Learning
IDENTIFIERS *Intuition (Mathematics)

ABSTRACT

Geometry is a fundamental part of the mathematics foundation provided by elementary education. Children have an intuitive understanding of geometry that they draw on when dealing with geometric concepts in activities like drawing, playing hopscotch, defending their "half of the room," and playing sports. This book offers no instruction in drawing, measuring, or formal reasoning, but has the goal of giving students in elementary school an intuitive grasp of plane geometry. The book is written for teachers who have had little or no geometry instruction, as well as teachers who know geometry well. It is organized into 12 lessons, consisting of 3 parts: a definition of terms and illustrative examples; an identification exercise; and a "treasure hunt" in the students' immediate surroundings for the geometric figures studied in the lesson. In addition, there are three review exercises and one final comprehension exercise. The answers to all the exercises are provided at the back of the book. The lesson topics are: (1) Perpendicular and Parallel Lines; (2) Right, Acute, and Obtuse Angles; (3) Polygons; (4) Right Triangles; (5) Scalene, Isosceles, and Equilateral Triangles; (6) Quadrilaterals, Rectangles, and Squares; (7) Parallelograms, Rhombuses, and Trapezoids; (8) Pentagons, Hexagons, and Octagons; (9) Circles; (10) Chords, Segments, Sectors, and Semicircles; (11) Inscribed Polygons, Tangent Lines, and Circumscribed Polygons; and (12) Congruent Polygons, Diagonals, and Complex Figures. (MDH)

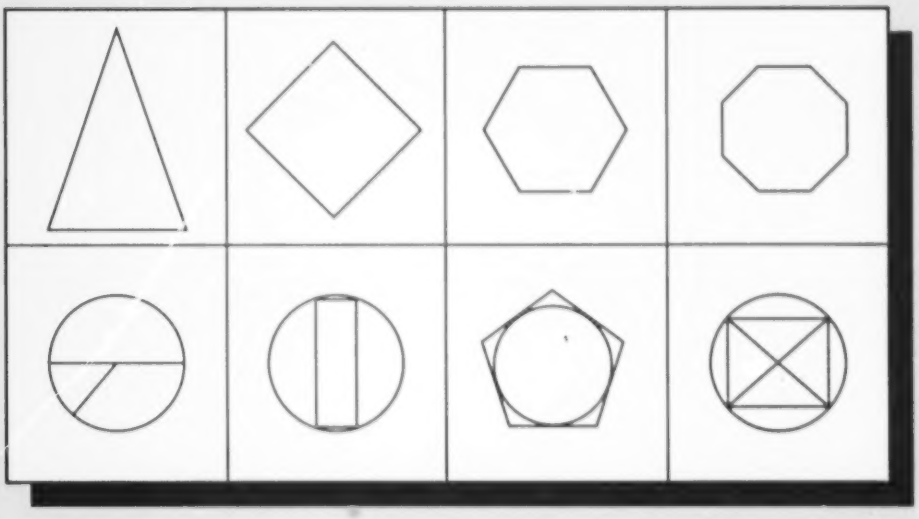
****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED342635

EARLY GEOMETRY

A Visual, Intuitive Introduction To Plane Geometry For Elementary School Children

by C.F. Navarro, Ph.D.



THE START SMART BOOKS

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

C. F. Navarro

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

SE052 323

BEST COPY AVAILABLE

Why Teach Geometry to Elementary School Children?

The main purpose of elementary education is to provide children with a solid academic foundation. Mathematics is unquestionably a critical part of that foundation, and—of the various branches of mathematics—geometry is one of the most fundamental.

Although mathematics is a complex subject, its basic notions are actually very simple—so children can grasp them readily. And geometry is perhaps the simplest and easiest branch of mathematics to comprehend. In essence, it is just an orderly way of understanding the world. The term, in fact, derives from the Greek for "geos" meaning earth and "metron" meaning measure—to take the measure of the world around us.

Children have an intuitive understanding of geometry. They are constantly dealing with geometric concepts in their drawings, their perceptions of buildings and streets in their neighborhood, their zealous defense of "my half of the room" or "my slice of the pizza," and their playing of hopscotch, baseball, and most other sports. Since geometry is such an integral part of children's daily lives, its study is an ideal way of introducing them to the nature of mathematics.

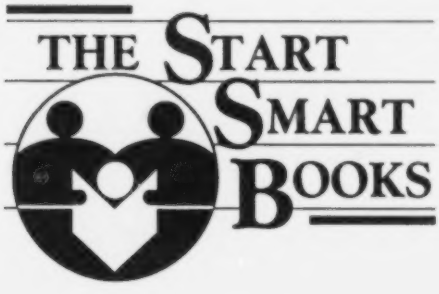
Why, then, is geometry not taught until high school? The reason, of course, is that full study of the subject requires at least a basic understanding of algebra. If, however, presented simply as figures —that is, without numbers—young children can readily "see" geometry and discover it in the physical world about them.

Taking the numbers out of geometry, moreover, does not in any way diminish the subject, since thus presented geometry retains its purity of form, its relationships, and its terminology. In fact, introducing geometric concepts and vocabulary in the early school years familiarizes children with the subject and gives them a solid foundation for its further study.

EARLY GEOMETRY

A Visual, Intuitive Introduction To Plane Geometry For Elementary School Children

by C.F. Navarro, Ph.D.



Early Geometry
© 1990 C. F. Navarro

THE START SMART BOOKS
P.O. Box 3446
Alexandria, Virginia 22302
(703) 836-3830

All rights reserved
including the right of reproduction
in whole or in part in any form.

Manufactured in the United States of America.

Early Geometry
ISBN 1-878396-04-8

ABOUT THIS BOOK AND HOW TO USE IT

(Please read carefully.)

What is *Early Geometry* about? The subject of the book is plane or two-dimensional geometry (squares, circles) as differentiated from solid geometry, which studies three-dimensional figures (cubes, spheres).

Can children use this book to learn geometry on their own? No. The book is not meant to be a self-teaching manual. As in all other titles in **The Start Smart Books,** the material must be presented and explained to the child by a teacher or tutor. Even the brightest children learn best when guided by an adult they respect and trust.

What is the grade level of the book? The book is so designed that it can be adapted for use at any elementary school grade.

How does the book differ from the standard high school text? *Early Geometry* offers no instruction in drawing, measuring, computing, or formal reasoning. Its sole aim is to give students in elementary school an intuitive grasp of plane geometry.

Exactly how much geometry can elementary school children be expected to learn from this book? Upon completion of the book, they should be able to identify and visually analyze all the major plane geometric figures.

How much geometry does their teacher need to know? The book is written for teachers who never had geometry or who may have forgotten what they once knew. All the information they need is contained in the book. They can learn or review the subject as they teach it to their students. The book can also be used by teachers who know geometry well, but may nonetheless have difficulty explaining it to young children.

How is the book organized? There are 12 lessons in all. Each lesson consists of three parts: a definition of terms and illustrative examples; an identification exercise; and a "treasure hunt" in the students' immediate surroundings for the geometric figures studied in the lesson. In addition, there are three review exercises and one final comprehension exercise. The answers to all the exercises are provided at the back of the book.

How is the subject developed? The book begins with lines and, in building-block fashion, joins the lines to form angles, angles to form simple shapes, and simple shapes to form complex figures. The teacher must make sure, therefore, that the students learn each lesson thoroughly before going on to the next.

How is the subject explained? The book is written in very simple, straightforward language. On the other hand, the subject is presented with its precise technical vocabulary. Clear thinking requires that things be called by their right name, and the correct names for figures like equilateral triangles and parallelograms are just that—"equilateral triangle" and "parallelogram." To call them by any other name would only confuse the student.

How is the subject illustrated? True geometric figures do not exist in a physical sense: they are mathematical abstractions. To really understand geometry students must learn to discern the outlines and shapes of objects as something apart from the objects themselves. They must see, for example, the difference between a sheet of paper and a rectangle. The book, therefore, uses no realistic illustrations. Sheets of paper are depicted simply as rectangles and pencils as straight lines. Throughout the book there are over 400 drawings.

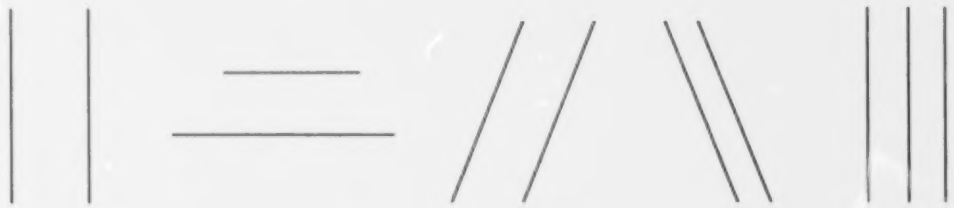
What additional materials would the students need? The answers to the identification problems may be written or given orally. If written, the students would, of course, need pencil and paper. If given orally, they would need no materials other than the book.

What kind of pictures and rewards does the book use to make the subject interesting to children? None of **The Start Smart Books** try to entertain students with cartoon-like drawings, coloring pictures, reward stickers, or anything of the sort. Such extraneous visual devices merely create distractions. **The Start Smart Books** encourage students to learn by making the subject itself entertaining—and any academic subject can be highly entertaining if presented as a source of enjoyment. In the case of *Early Geometry*, the fun students have with its game-like exercises and "treasure hunts" is all the reward they need to learn geometry.

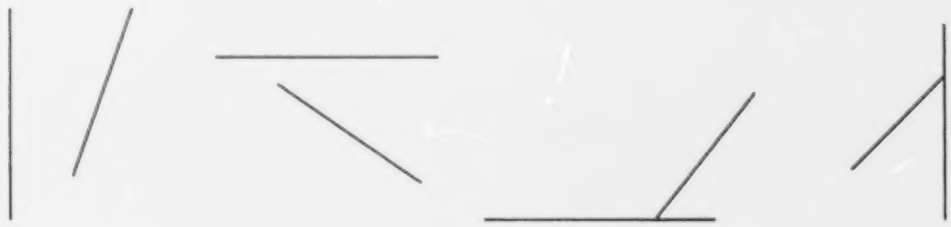
Lesson 1: Perpendicular and Parallel Lines

When two straight lines meet in such a way that they form a square corner (a 90-degree angle, to be precise) the lines are said to be **perpendicular** to each other. The abutting lines below, for example, are perpendicular:

When two or more straight lines lie on the same plane in such a way that they are always the same distance apart and, therefore, would never meet no matter how far they were extended, then the lines are **parallel**. The sets of lines below, for example, are parallel:

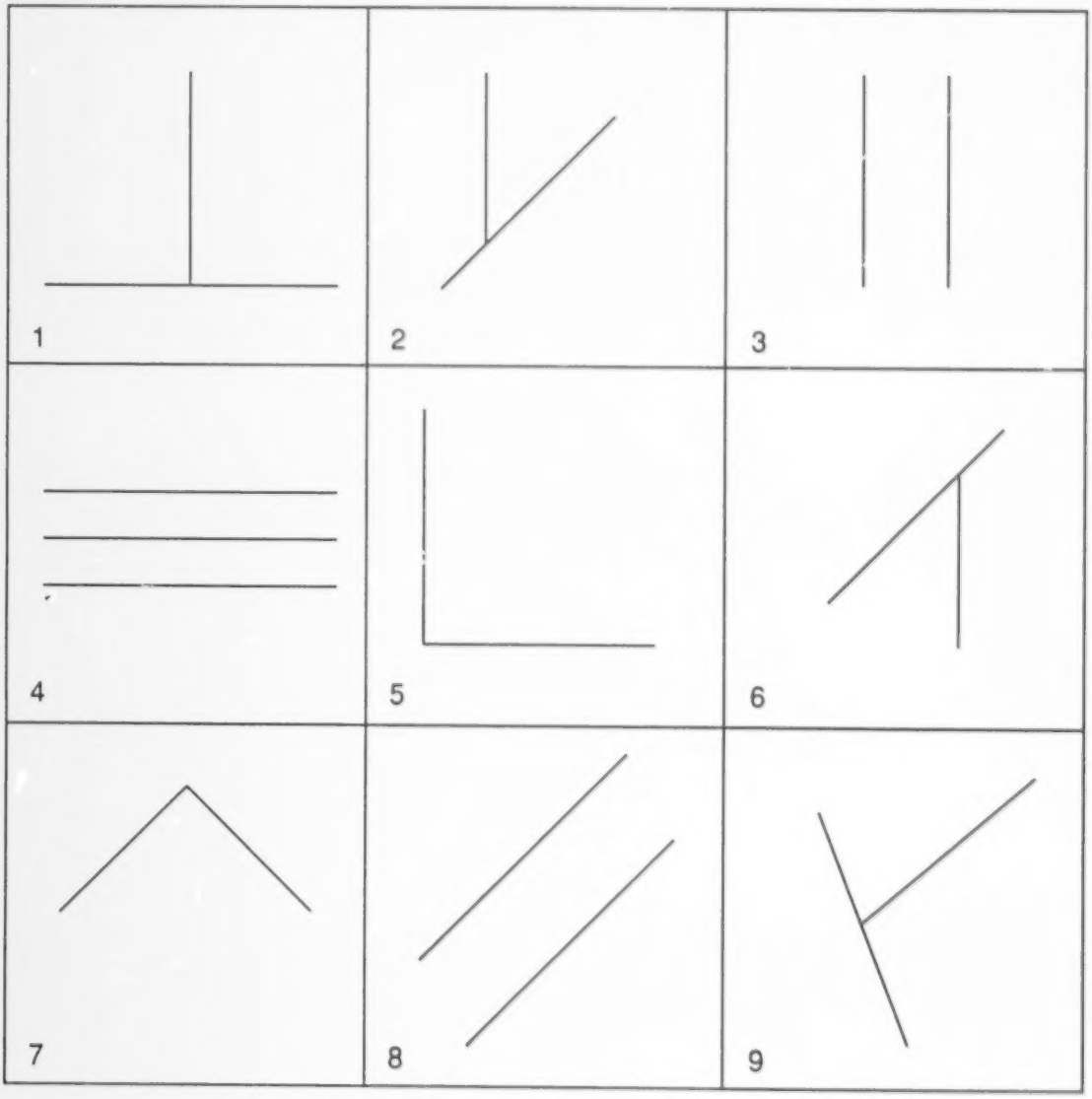


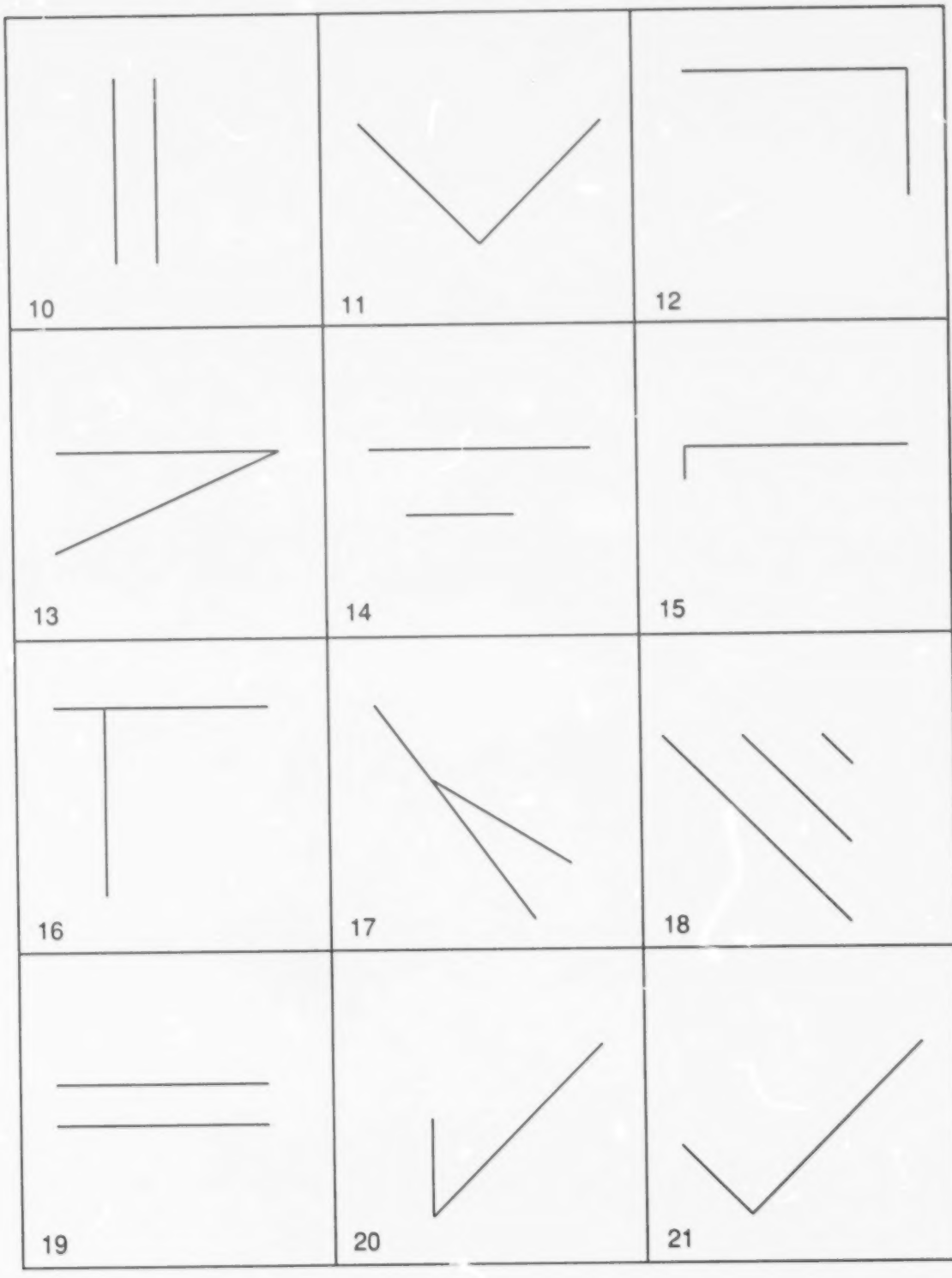
These lines, on the other hand, are neither parallel nor perpendicular:



Exercise 1

Identify each set of lines below as follows: "perpendicular," "parallel," or "neither."

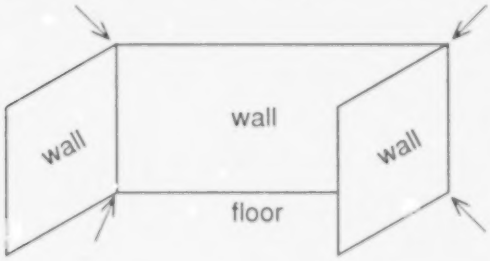



10
11
12
13
14
15
16
17
18
19
20
21

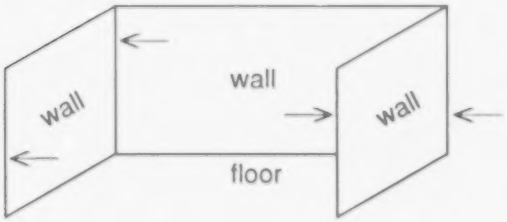
Treasure Hunt

Look around your room and you will find all sorts of things with perpendicular and parallel lines. The corners of rectangular or square objects–books, index cards, doors–are formed by perpendicular lines. The opposite edges of these same objects, on the other hand, run in parallel lines.

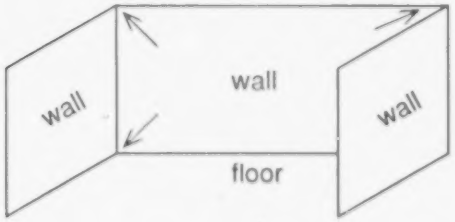
If the walls, floor, and ceiling of your room are rectangular, as is the case with most rooms, then the room itself will provide you with some good examples of perpendicular and parallel lines.



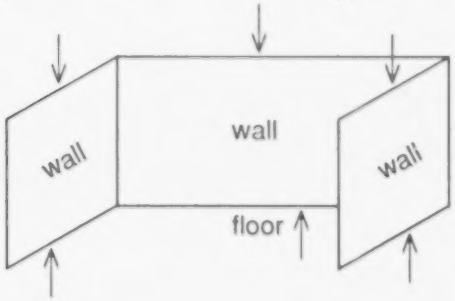
The vertical corner lines are perpendicular to the horizontal lines where the walls abut the floor and ceiling.



The vertical corner lines are parallel.



The horizontal lines where the walls abut the floor and ceiling are perpendicular at the points where they meet.

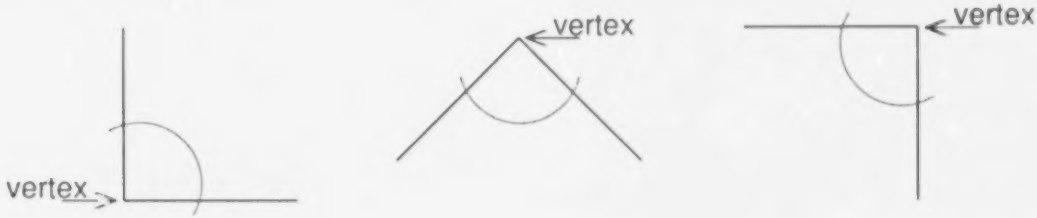


The horizontal lines where the walls abut the floor and ceiling are parallel to each other as well as to those on the opposite side of the room.

Lesson 2: Right, Acute, and Obtuse Angles

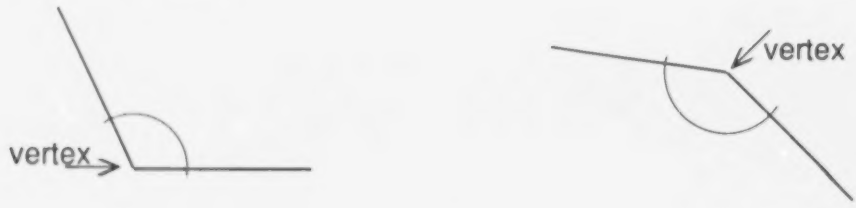
When two straight lines meet, the space between them is called an **angle**. The exact point where the lines meet is the **vertex** of the angle. The plural of vertex is **vertices**.

If the lines that form the angle are perpendicular, then the angle is called a **right angle**. The angles below are right angles (the arc indicates the span of the angle):



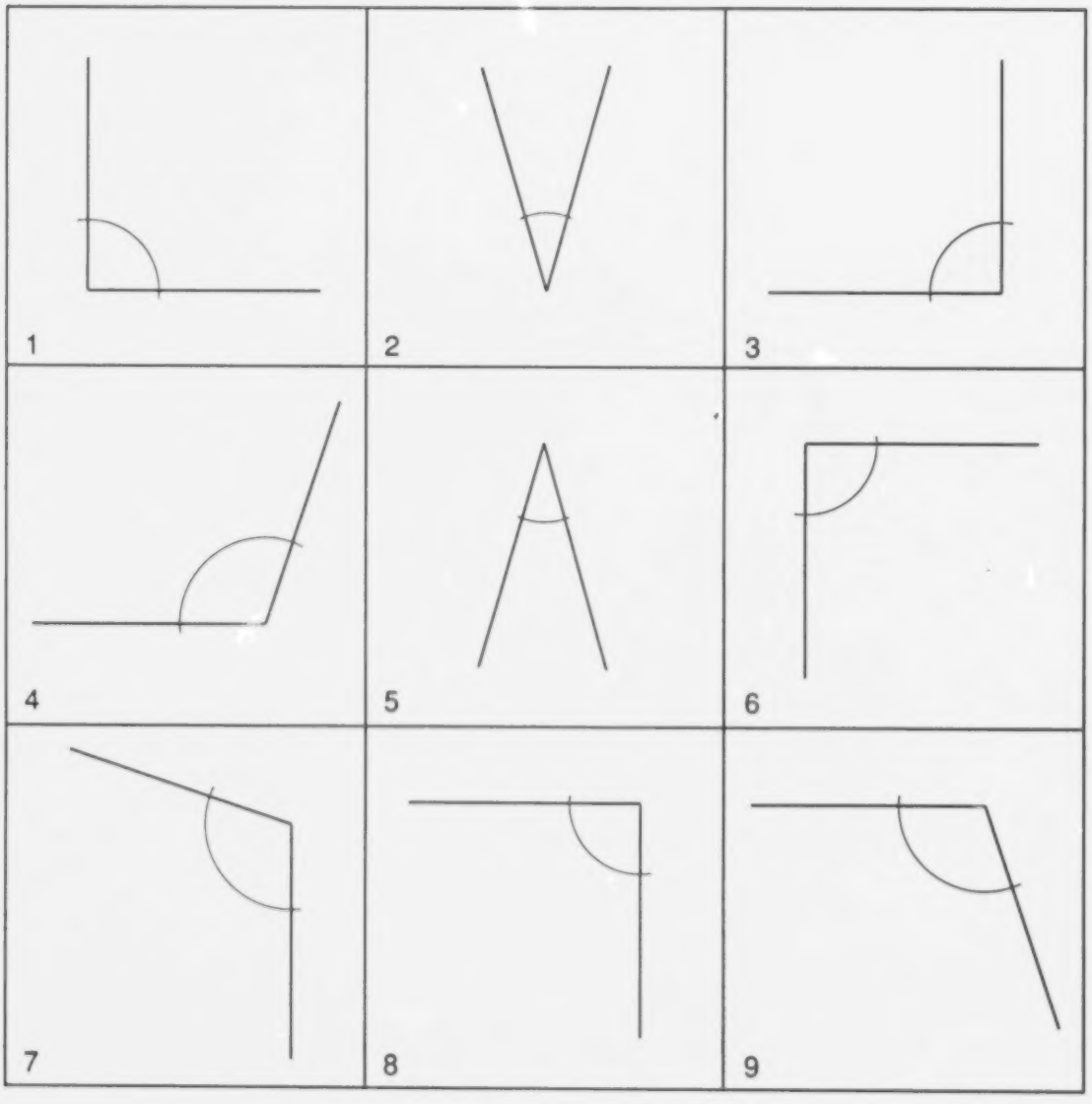
If the angle is smaller than a right angle but not so small that its sides come together, the angle is called an **acute angle**. These angles are acute:

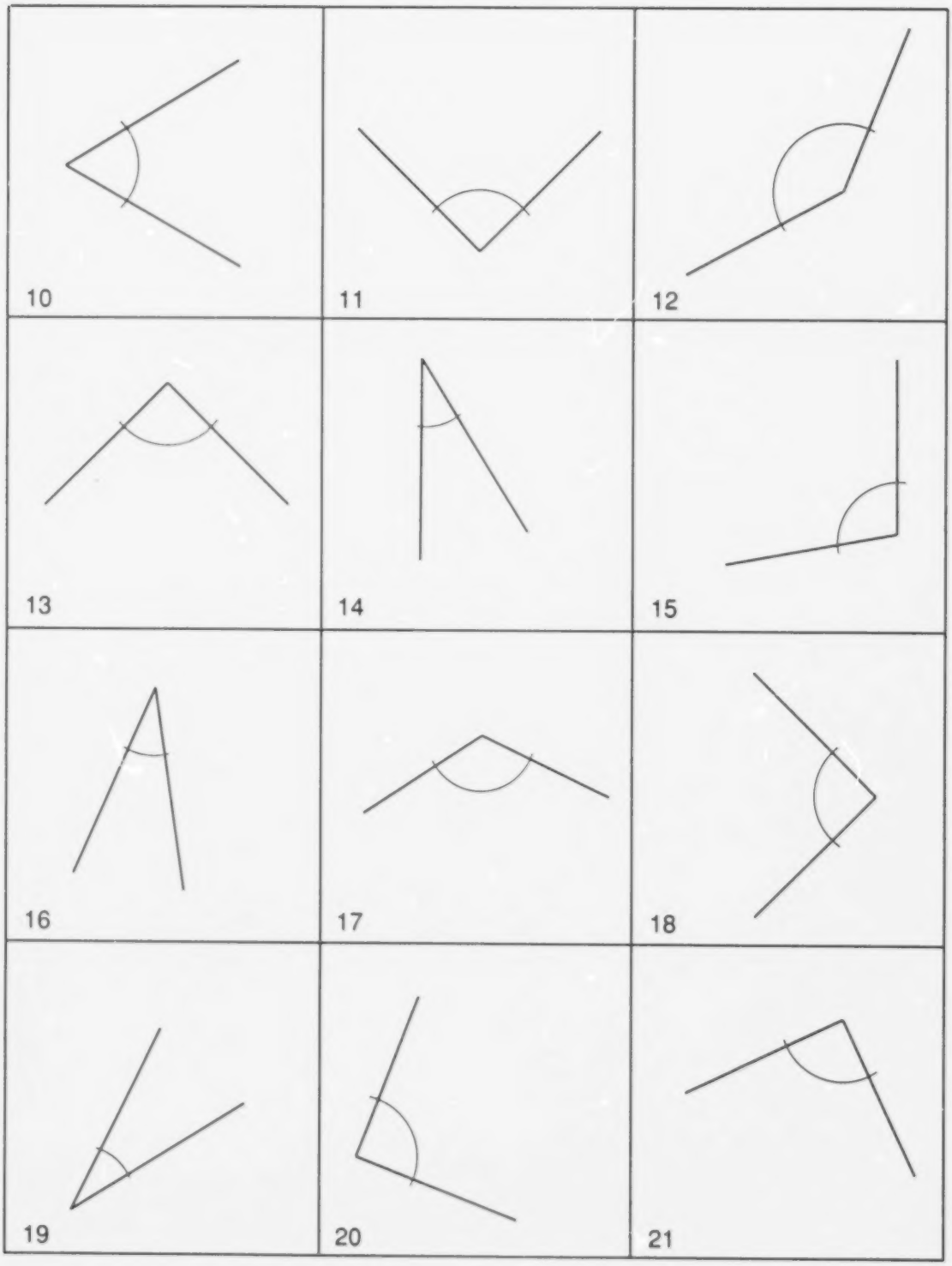
If the angle is larger than a right angle but not so large that its sides open up into a straight line, the angle is called an **obtuse angle**. These angles are obtuse:



Exercise 2

Identify each angle below as follows: "right," "acute," or "obtuse."



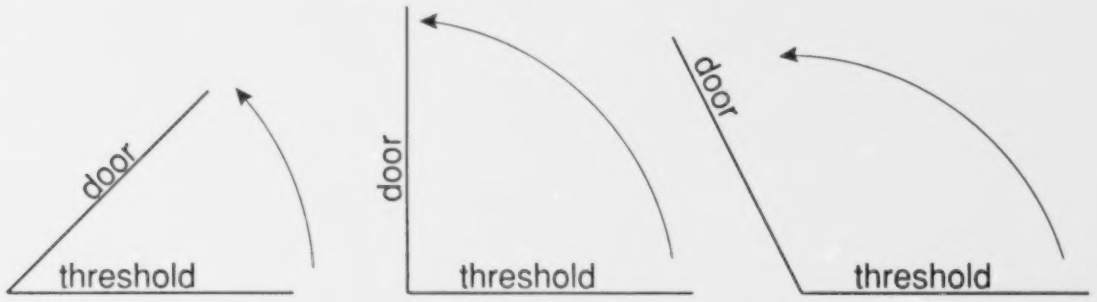

10
11
12
13
14
15
16
17
18
19
20
21

Treasure Hunt

You will find right angles in the very same places you found perpendicular lines. The corners of many objects–tables, sheets, cards, books, dollar bills, doors, windows, walls, floors, ceilings–are right angles.

You will also find right angles in the uppercase letters L, E, F, H and T. The uppercase letters A, M, N, V, X, Y and Z are formed with acute angles, and the K with one obtuse (or sometimes one right) and two acute angles.

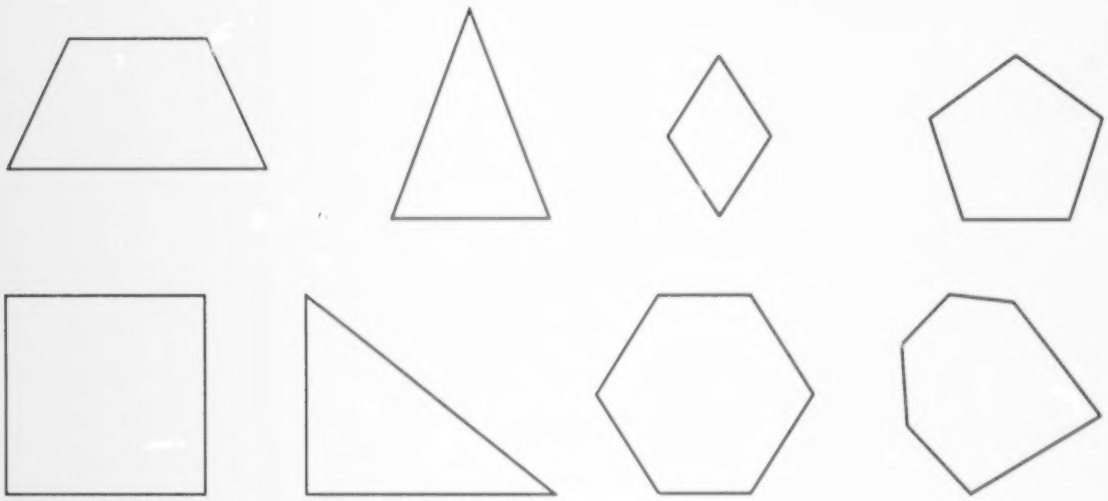
Acute and obtuse angles are not as easy to find as right angles. You can, however, generate as many as you wish by merely opening and closing a door. The angles formed by the bottom edge of the door and the threshold will range from small acute angles to large obtuse ones. At one exact point in the swing of the door, the angle will be a right angle.



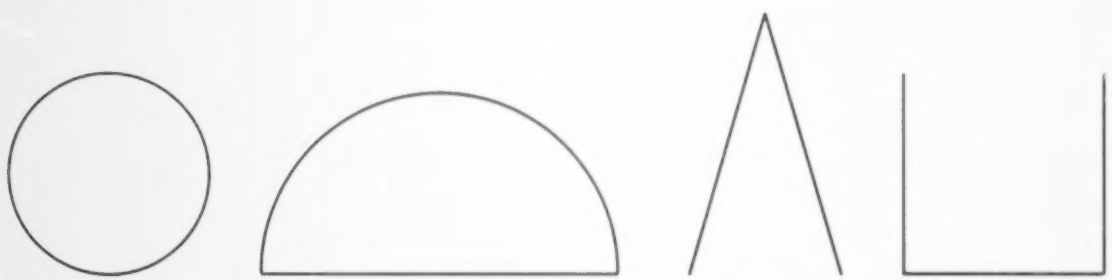
Similarly, you can generate every possible acute and obtuse angle by opening and closing the covers of a hard-back book. In the treasure hunt of the next lesson, you will learn about yet another way of generating angles.

LESSON 3: POLYGONS

A **polygon** is a closed flat or plane figure bounded by straight lines. The lines that form a polygon are called its **sides**. Here are some polygons:



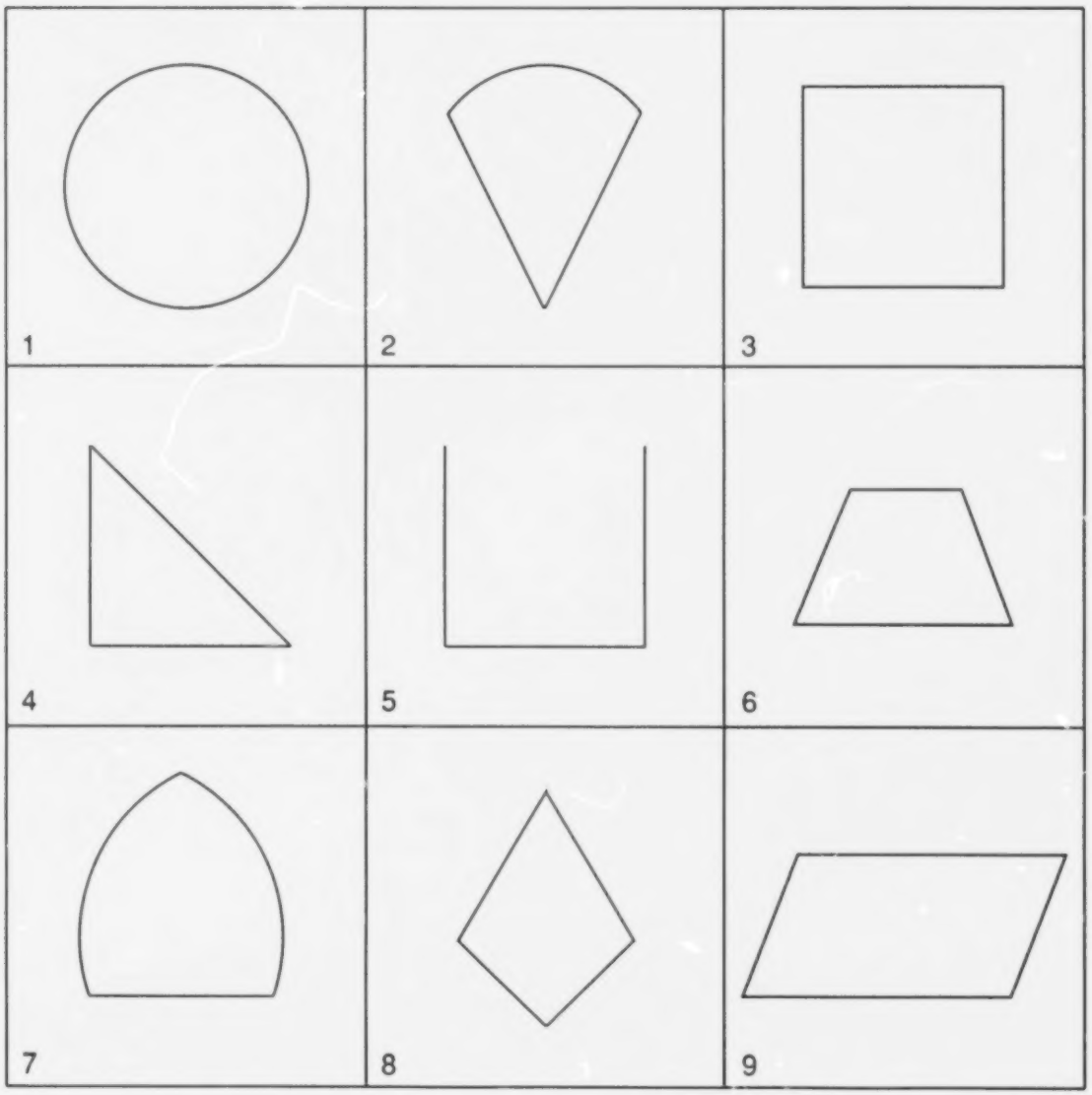
Note that polygons have as many angles as they have sides. Figures with curved lines or gaps are not polygons. These figures, for example, are not polygons:

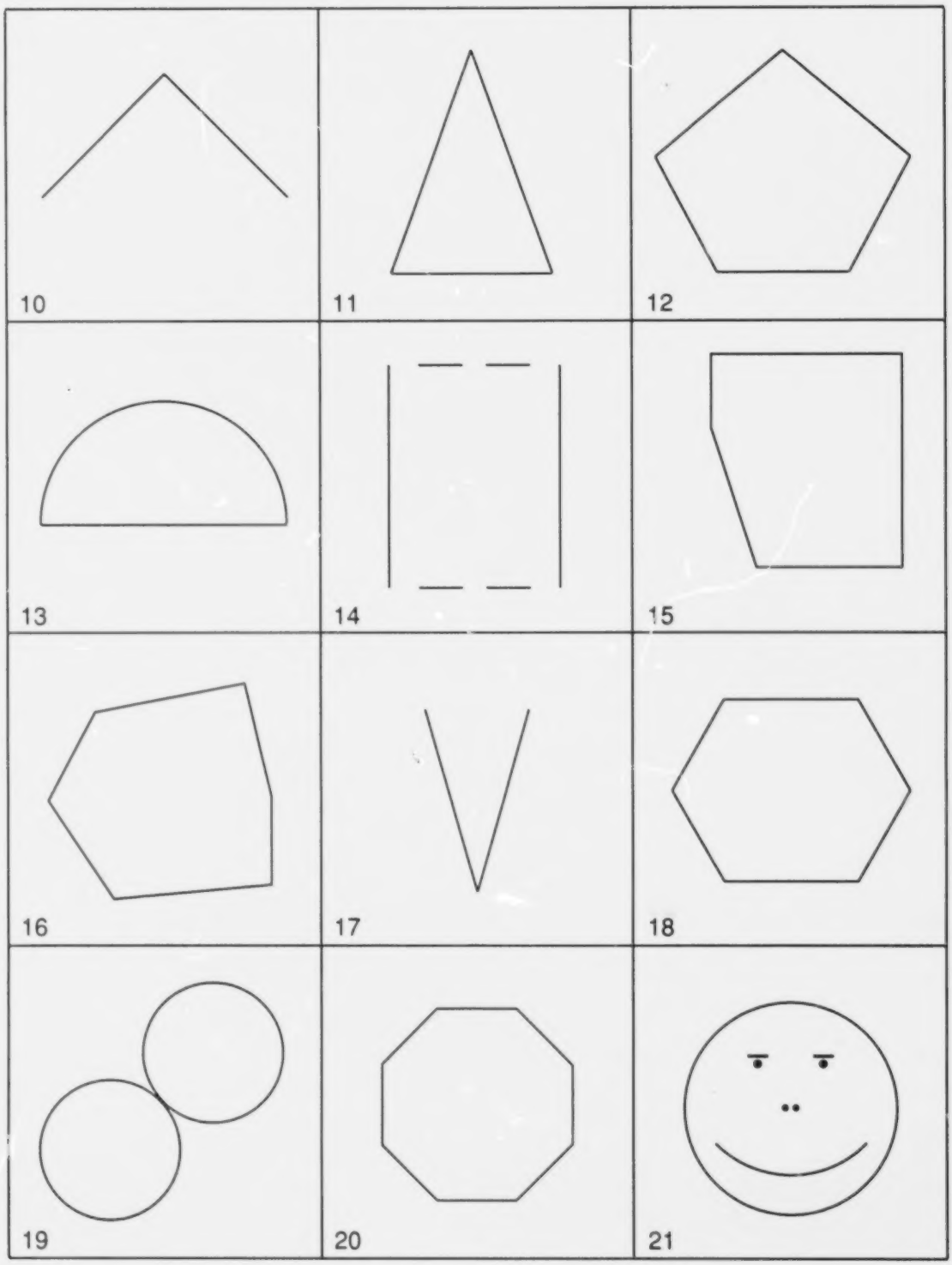


Plane geometric figures are perfectly flat. Physical objects like books and coins, therefore, cannot be plane geometric figures, because they have thickness. Even the thinnest sheet of paper is much too thick to qualify as a true plane geometric figure. So, in your treasure hunts do not look at whole objects, but concentrate instead on their outlines.

Exercise 3

Identify each figure below as follows: "polygon" or "not a polygon."



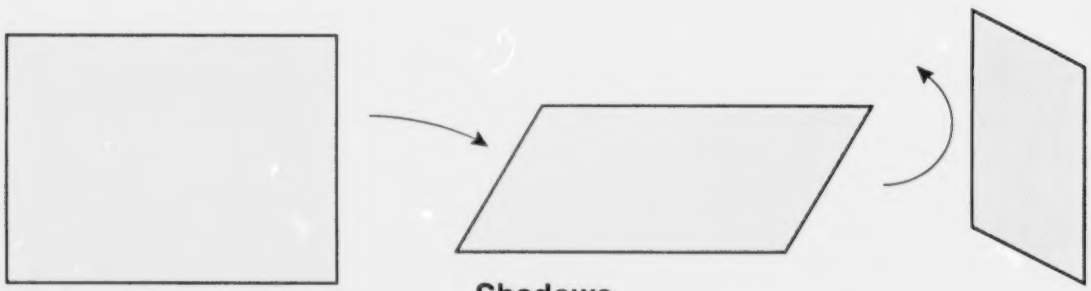

10
11
12
13
14
15
16
17
18
19
20
21

Treasure Hunt

The outlines of flat objects with straight edges are polygons. On the other hand, the outlines of objects with curved edges are non-polygons. Even if the edge of an object has but one tiny curve, its outline must be regarded as a non-polygon.

You will find polygons in the outlines of objects such as cards, doors, windows, tiles, and stop signs. You will find non-polygons in things like saucers, coins, door knobs, and shoe soles.

You can also use shadows to generate all kinds of polygons and non-polygons. For example, to generate other four-sided polygons from a rectangle, hold a book in front of a light so that it casts a shadow on a wall or the floor. The natural light of the sun shining through a window will usually give the most distinct shadows. Rotate and turn the book in different directions and the rectangular shadow will change shape. At times, it will diminish into a mere line. Also, its right angles will change variously into acute and obtuse angles, and back to right angles again.



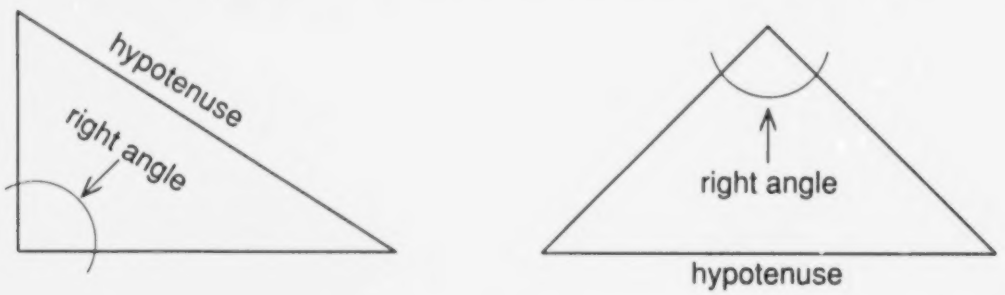
Shadows

As with the door and threshold in the treasure hunt of Lesson 2, you can generate all sort of angles by altering the shadow of a polygon.

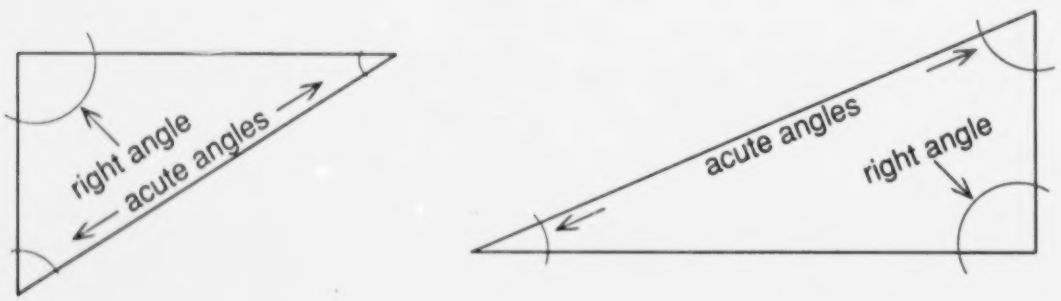
Lesson 4: Right Triangles

A polygon with three sides is called a **triangle**. Since three is the minimum number of lines required to form a closed figure, triangles are the simplest of all polygons. These polygons are triangles:

A triangle with a right angle is called a **right triangle**. The side opposite the right angle of the triangle is called the **hypotenuse**. The hypotenuse is always the longest side of a right triangle. These triangles are right triangles:

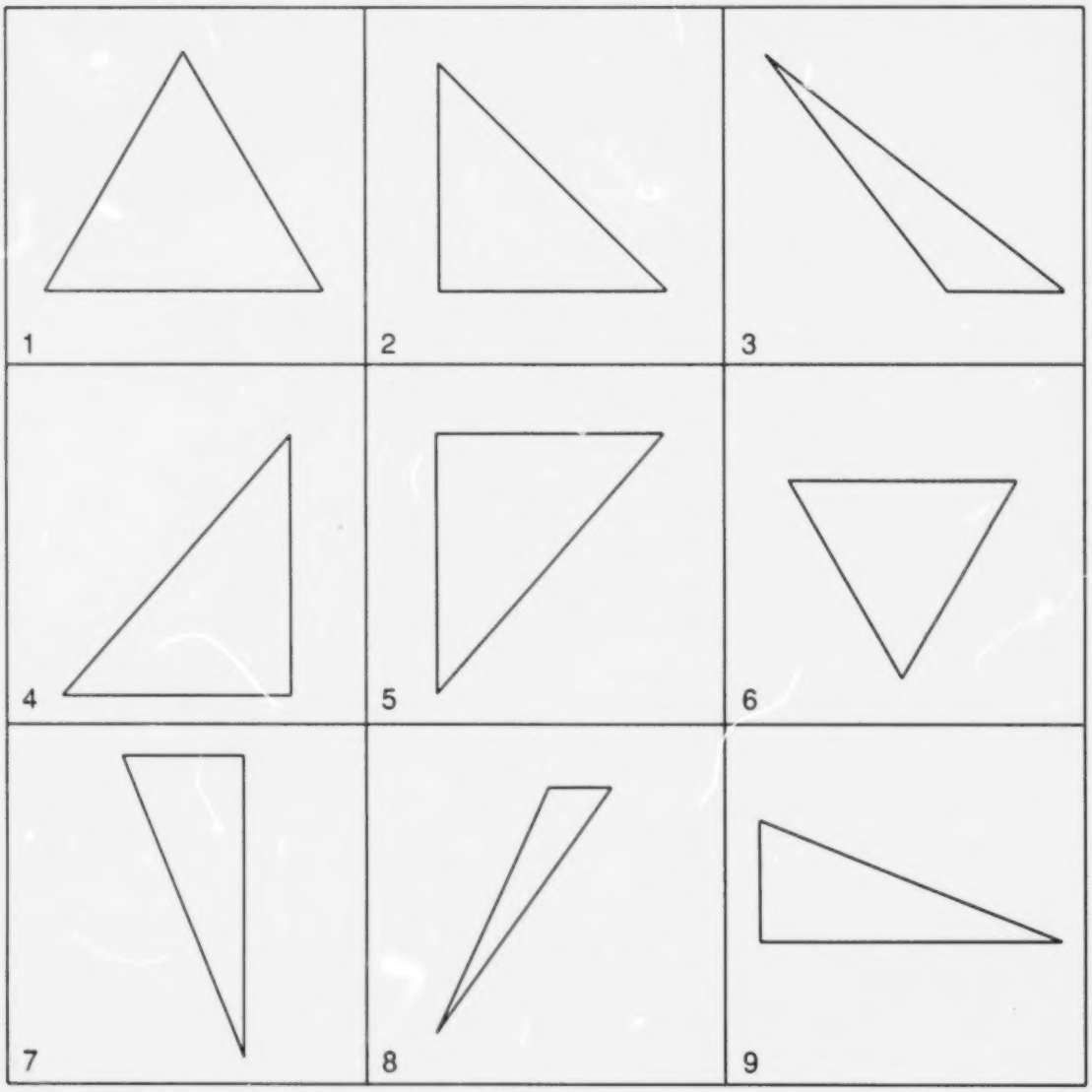


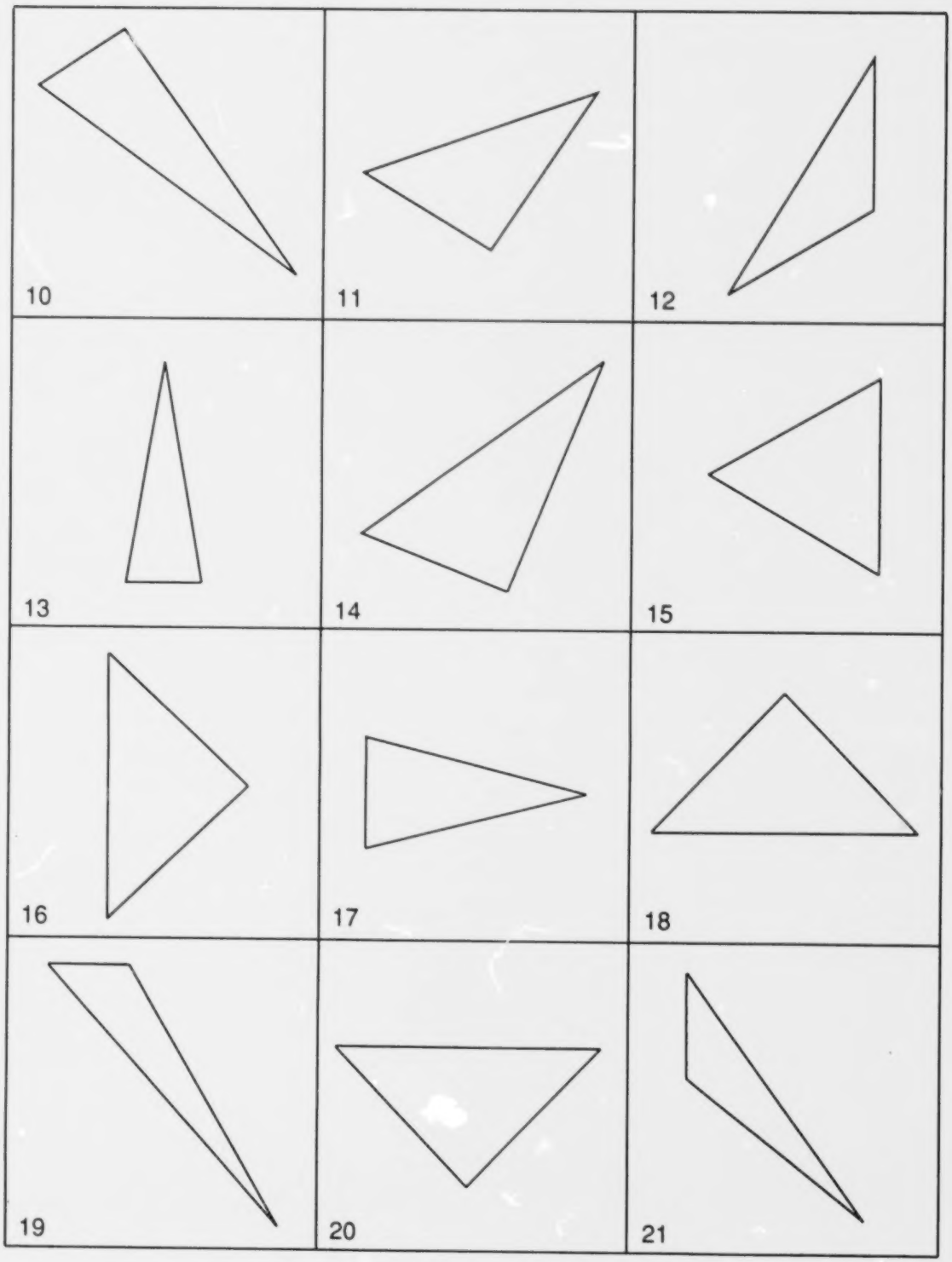
Note that in all right triangles, the two angles besides the right angle are acute. No right triangle can have an obtuse angle.



Exercise 4

Identify each triangle below as follows: "right triangle" or "other triangle."

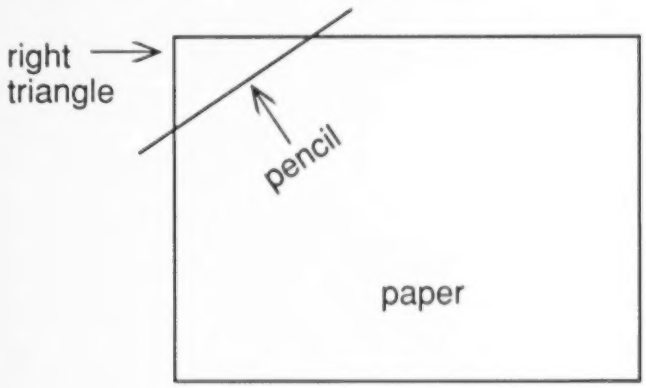




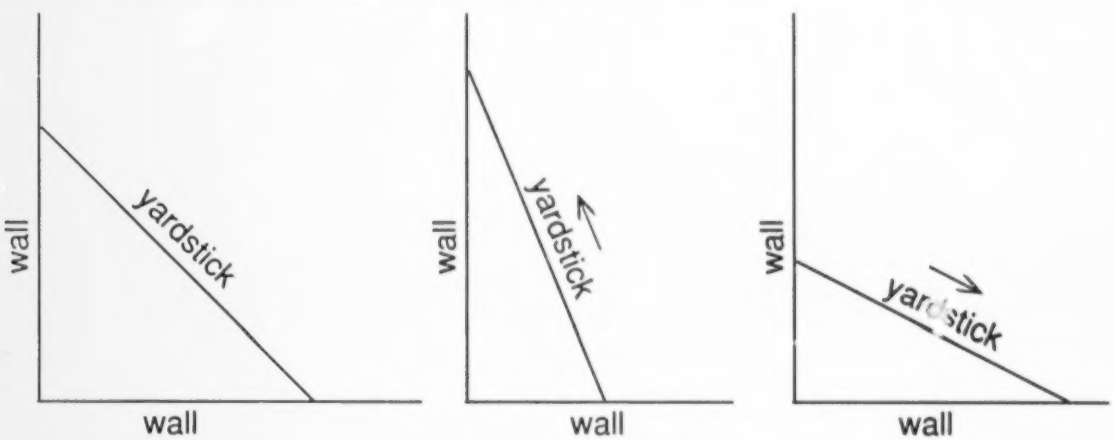
15

Treasure Hunt

You may not be able to find a right triangular object in your room. However, you can easily make a right triangle from a corner of any rectangular object. For instance, if you place a pencil across the corner of a sheet of paper, the triangle thus formed will be a right triangle.



An interesting way to generate right triangles is by placing a yardstick against the corner of your room, so that one end of the yardstick is touching one of the abutting walls, and the other end the other wall. Keeping the yardstick level (you might prefer to lay it on the floor), work its ends left and right across the walls and watch how the shape of the right triangle changes. The hypotenuse, the yardstick, is always the same, but the length of the other two sides along the wall will change: as one gets longer, the other gets shorter. At the same time, the acute angle formed by the hypotenuse and a side grows larger as the side gets shorter, and smaller as the side gets longer. The right angle, on the other hand, will remain unchanged.

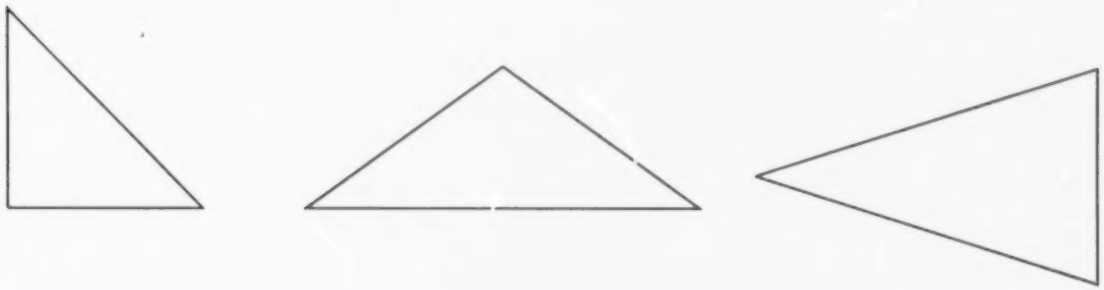


Lesson 5: Scalene, Isosceles, and Equilateral Triangles

In Lesson 4 we learned to identify a particular kind of triangle, the right triangle, in terms of one of its angles. In this lesson, we will learn to identify triangles in general, including right triangles, in terms of their sides.

A triangle whose three sides are unequal in length is called a **scalene triangle**. These triangles are scalene:

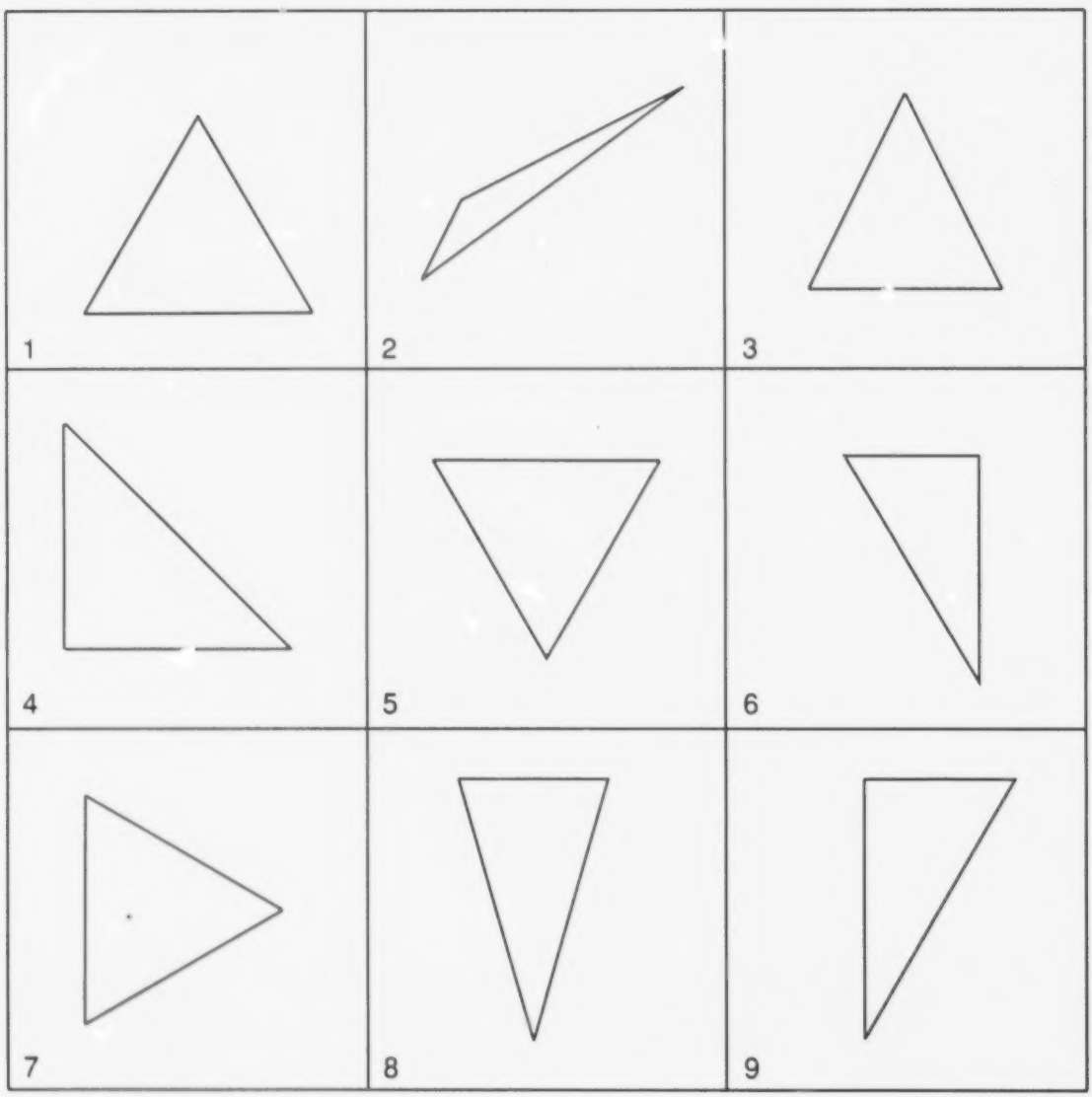
A triangle with two equal sides is called an **isosceles triangle**. These triangles are isosceles:

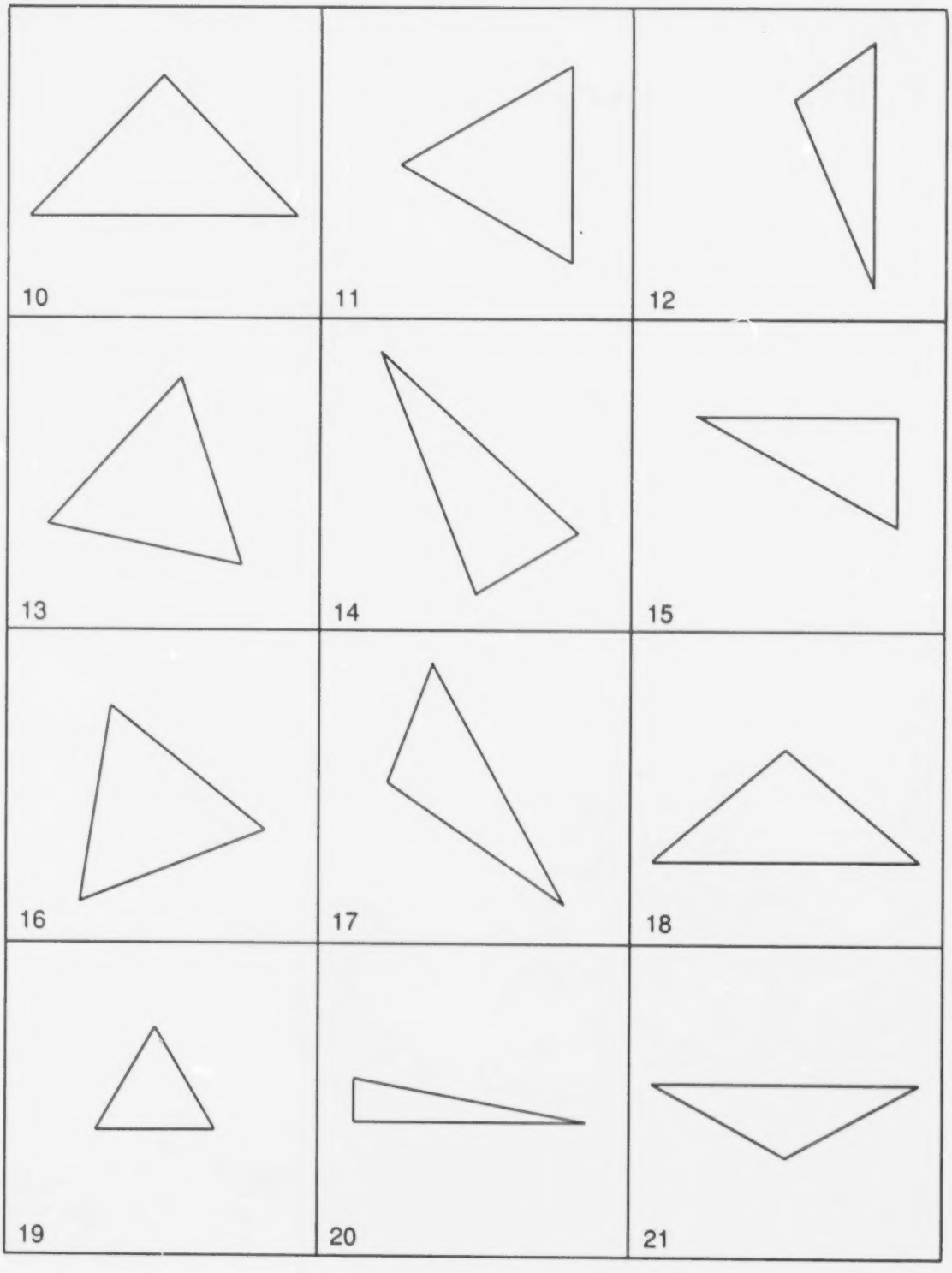


A triangle whose three sides are equal is an **equilateral triangle**. These triangles are equilateral:

Exercise 5

Identify each triangle below as follows: "scalene," "isosceles," or "equilateral." (A right triangle can be scalene or isosceles but never equilateral, because–as you saw in Lesson 4–its hypotenuse is always longer than its two other sides.)




10
11
12
13
14
15
16
17
18
19
20
21

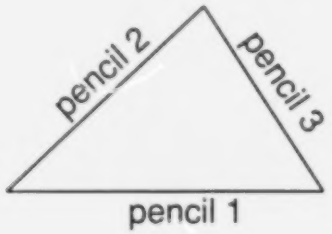
Treasure Hunt

You may not be able to find any ready-made scalene, isosceles, or equilateral triangles lying around in your room. You can, however, fashion your own very easily. For a scalene triangle, place three pencils of unequal length end to end so that they form a closed figure.

_____ pencil 1

_____ pencil 2

_____ pencil 3

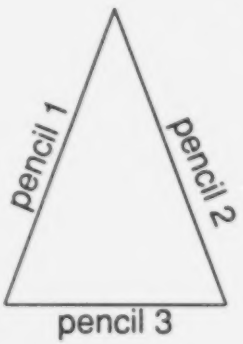


For an isosceles triangle put two pencils of equal length together with a shorter or slightly longer one. (If the odd pencil is too much longer, you may not be able to close the figure.)

_____ pencil 1

_____ pencil 2

_____ pencil 3

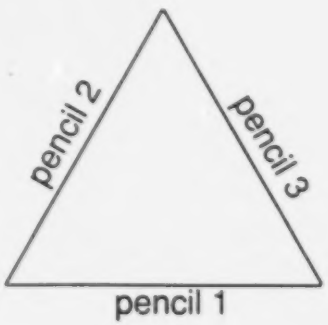


And for an equilateral triangle use three pencils of equal length.

_____ pencil 1

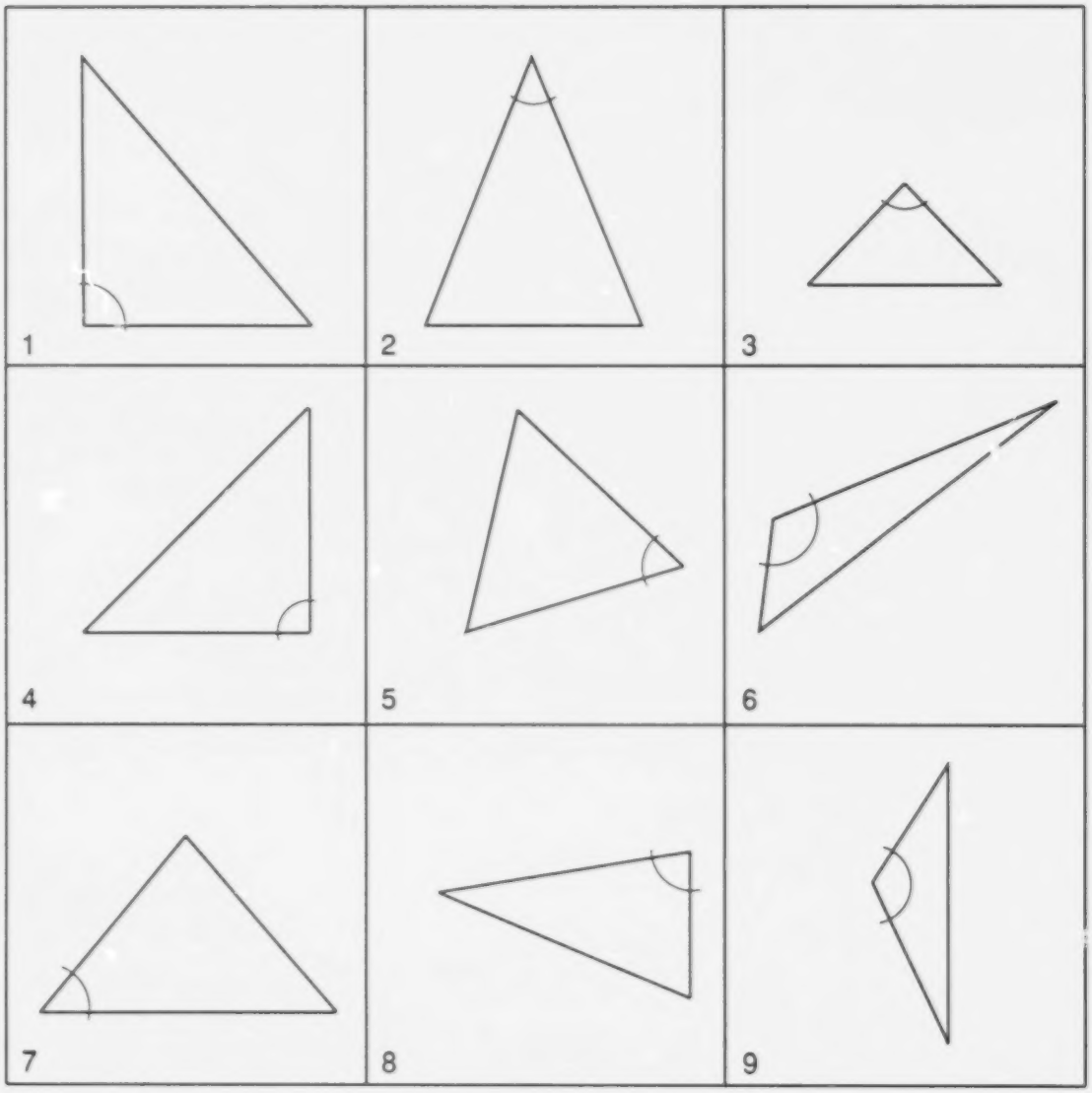
_____ pencil 2

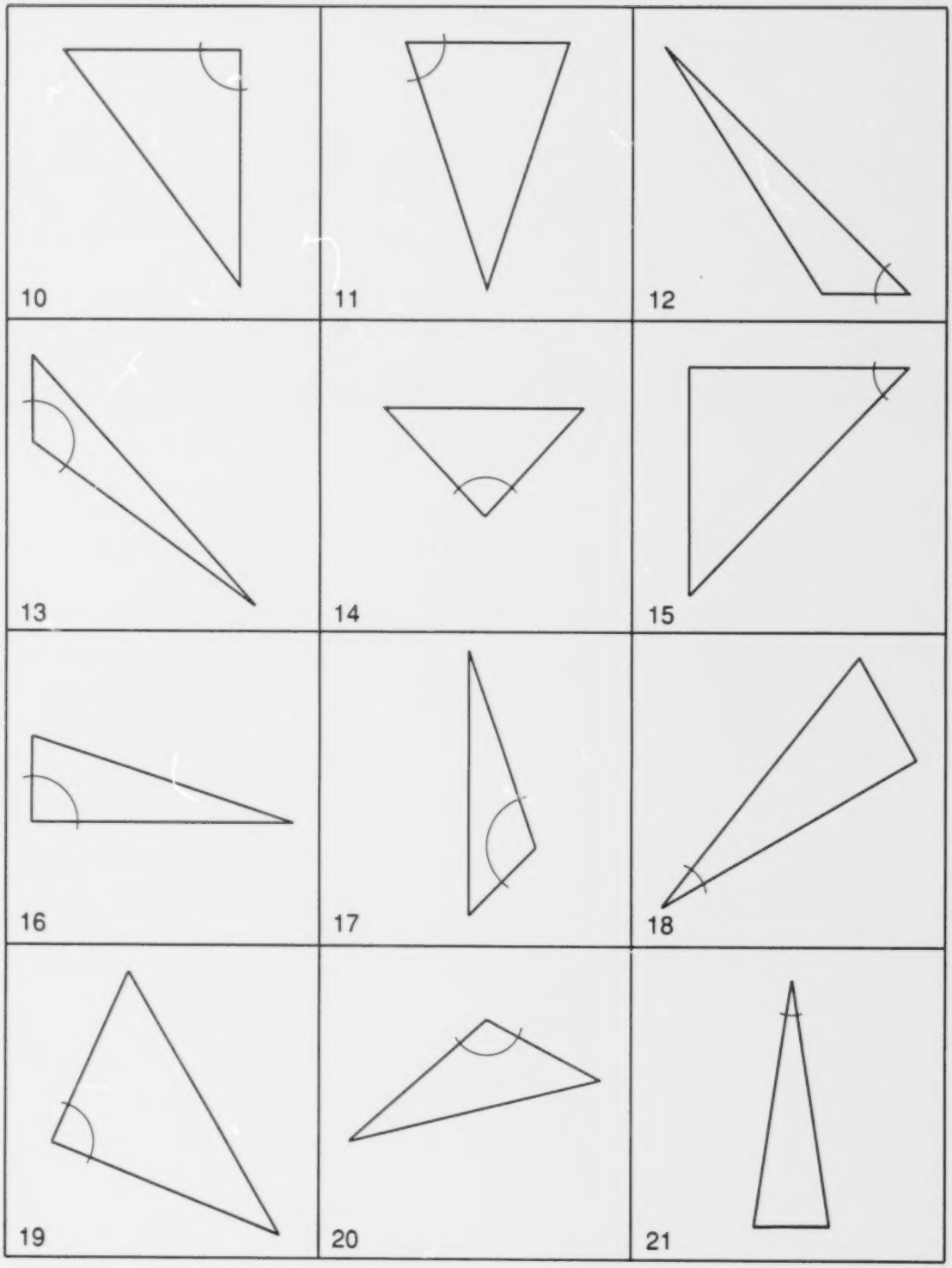
_____ pencil 3



Review Exercise A

Identify the kind of angle marked by an arc in each of the figures below.

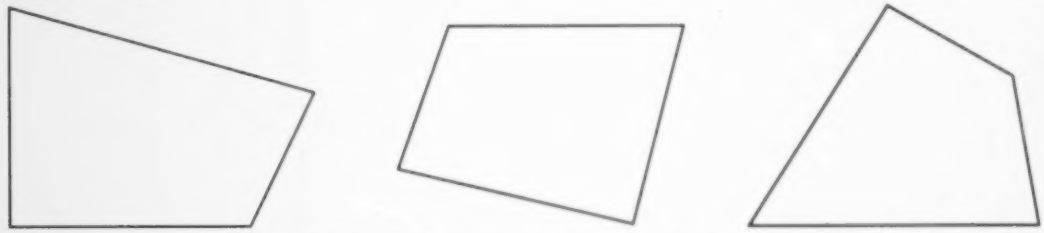




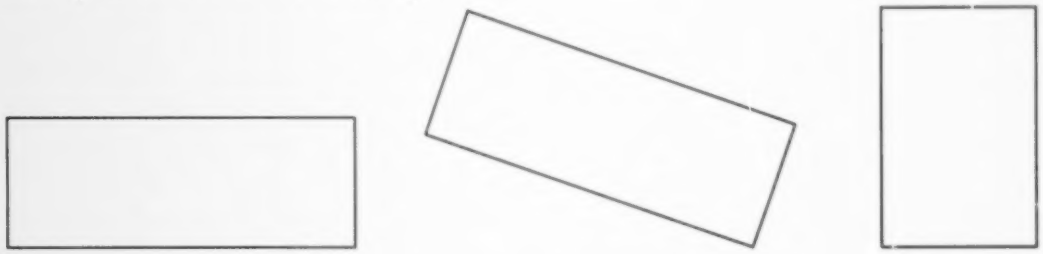
22

Lesson 6: Quadrilaterals, Rectangles, and Squares

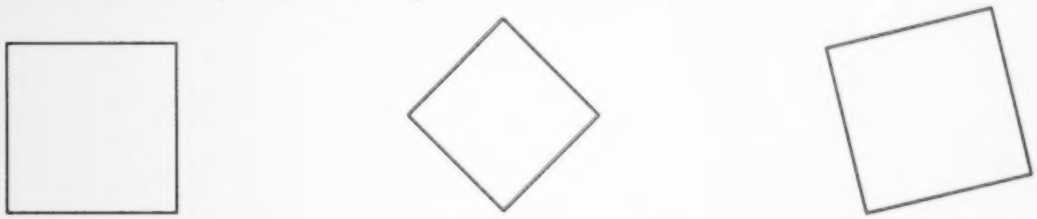
A polygon with four sides is called a **quadrilateral**. These polygons are quadrilaterals:



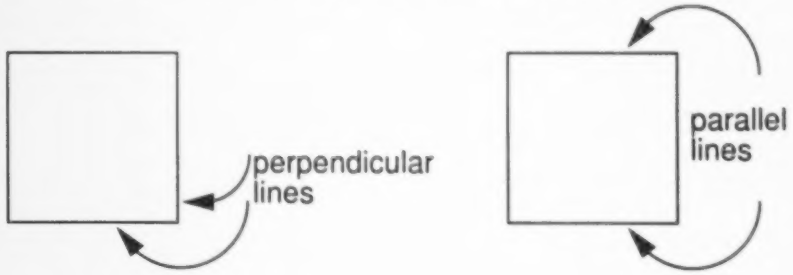
A quadrilateral whose four angles are all right angles is called a **rectangle**. These quadrilaterals are rectangles:



A quadrilateral whose four angles are right angles and whose four sides are equal is called a **square**. These quadrilaterals are squares:

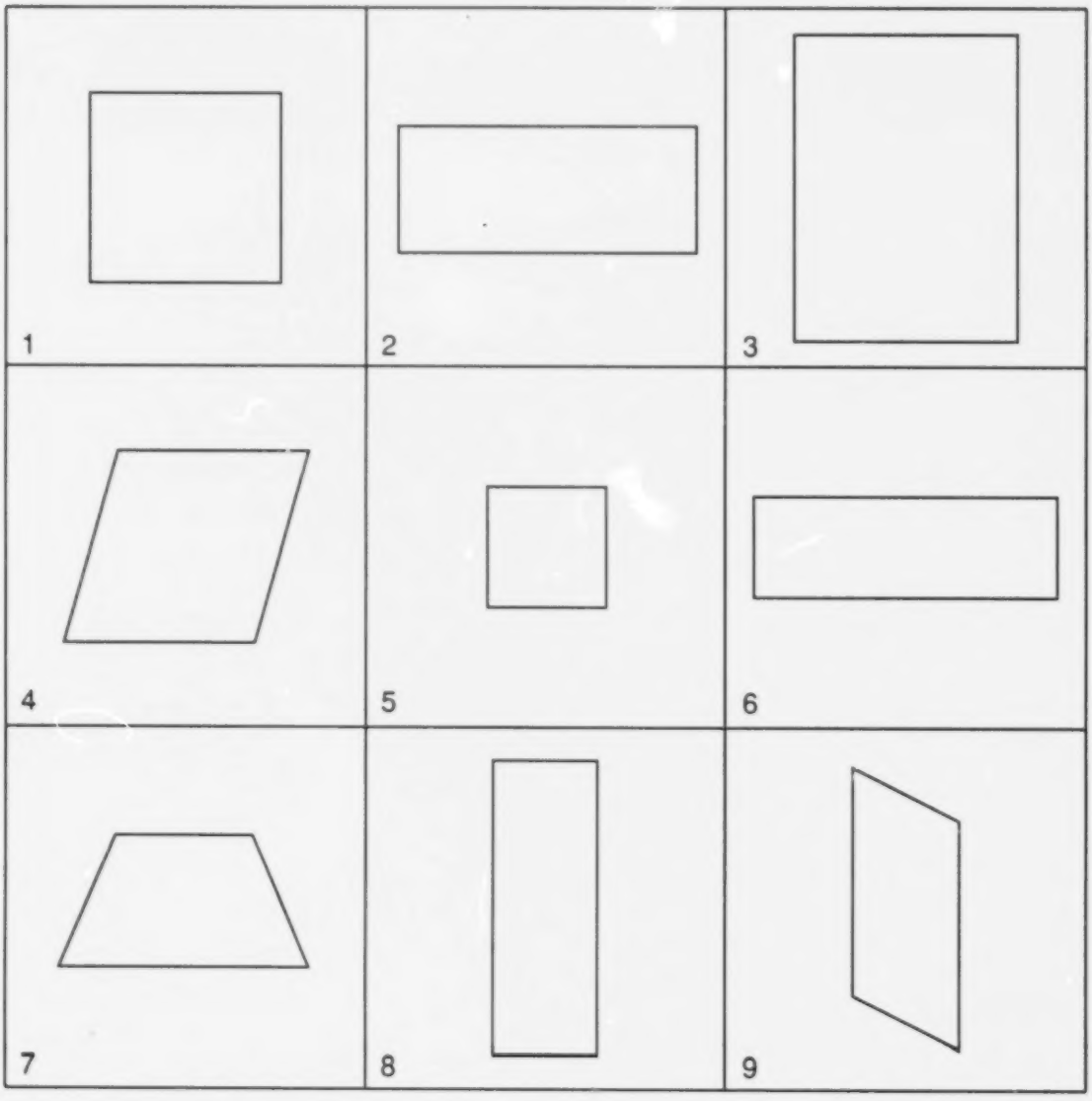


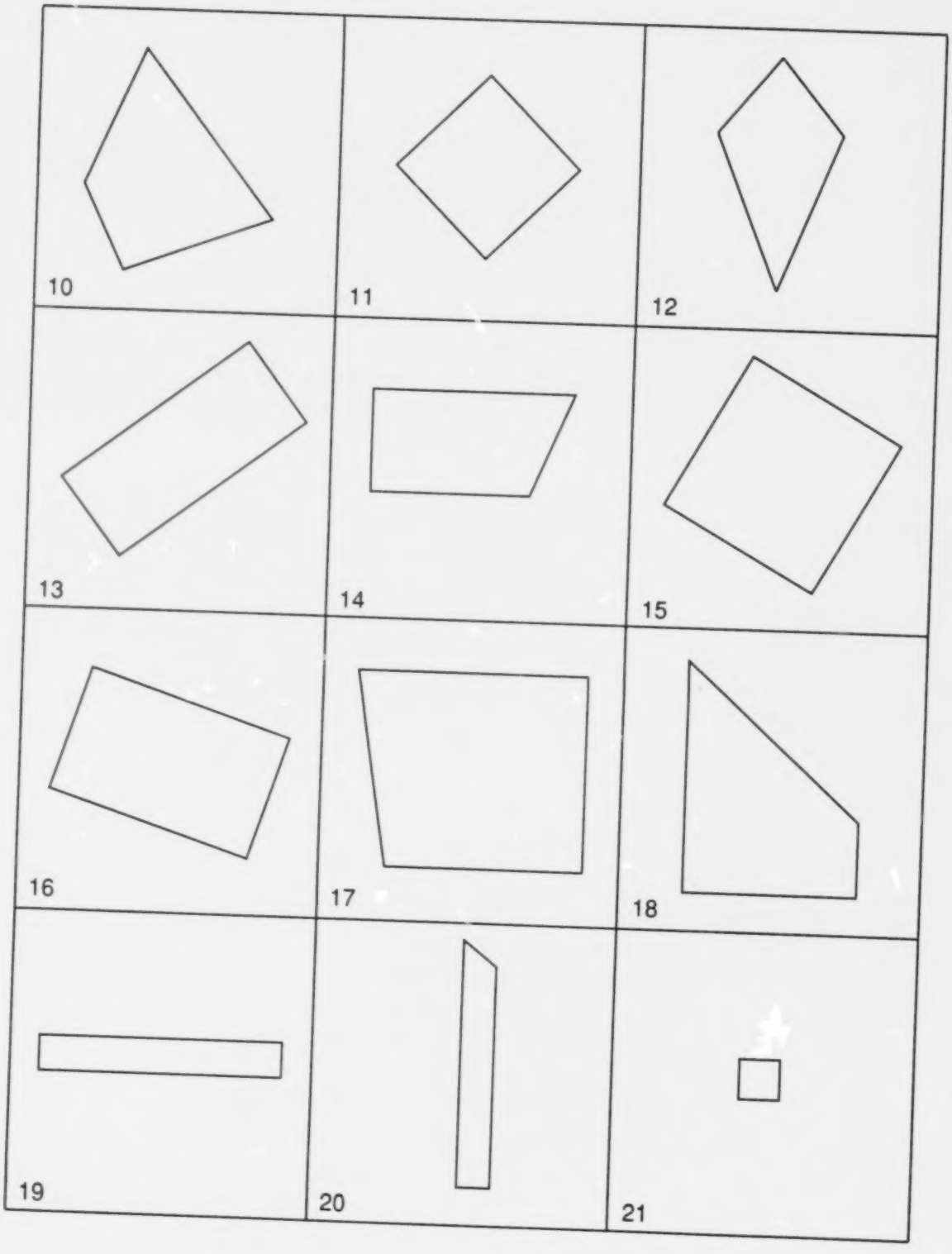
Note that the abutting or adjacent sides of all rectangles and squares are perpendicular lines, while their opposite sides are parallel lines.



Exercise 6

Identify each quadrilateral below as follows: "rectangle," "square," or "other quadrilateral." (Note that, by definition, a square is a special kind of rectangle.)

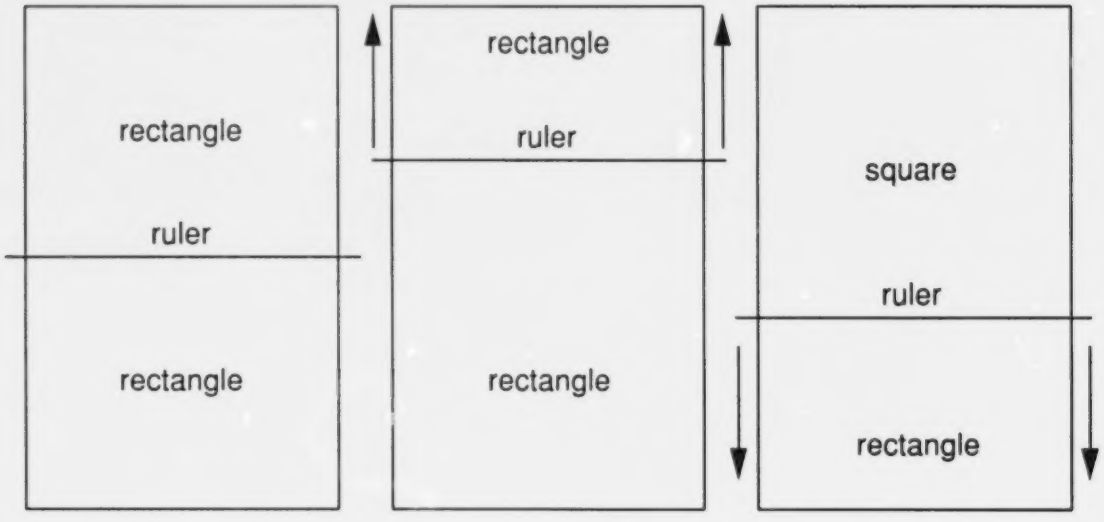



10
11
12
13
14
15
16
17
18
19
20
21

Treasure Hunt

You should have no trouble at all finding rectangles or squares: the outlines of books, blocks, blankets, towels, boxes, newspapers, index cards, paper money, bricks, floor tiles, tennis courts, football fields, baseball diamonds–to name a few–are rectangular or square.

You can also generate as many rectangles as you wish from one single rectangular object. Place a ruler across a sheet of standard notebook paper so that the edges of the ruler are parallel to the short sides of the sheet and perpendicular to the long sides. Then, keeping the ruler straight, slide it up and down the paper and observe how the rectangles on both sides of the ruler change. Note that for each side there is only one place where you can position the ruler and form a square.

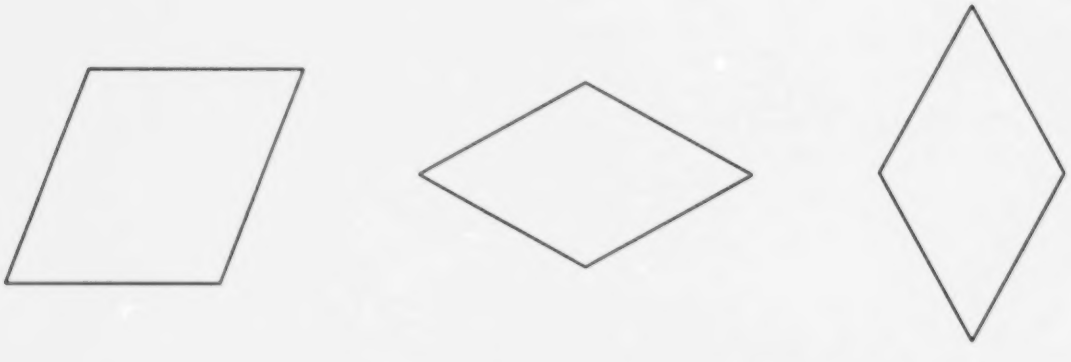


You can also generate all kinds of quadrilaterals by placing pencils end to end, as you did in Lesson 5 to make triangles, except that here you would, of course, use four rather than three pencils.

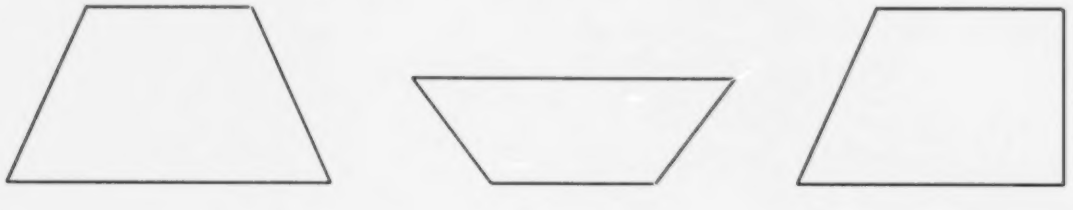
Lesson 7: Parallelograms, Rhombuses, and Trapezoids

A quadrilateral whose opposite sides are parallel is called a **parallelogram**. These quadrilaterals are parallelograms:

In art and design a parallelogram whose four sides are equal is called a diamond, but in geometry such a figure is called a **rhombus**. These parallelograms are rhombuses:

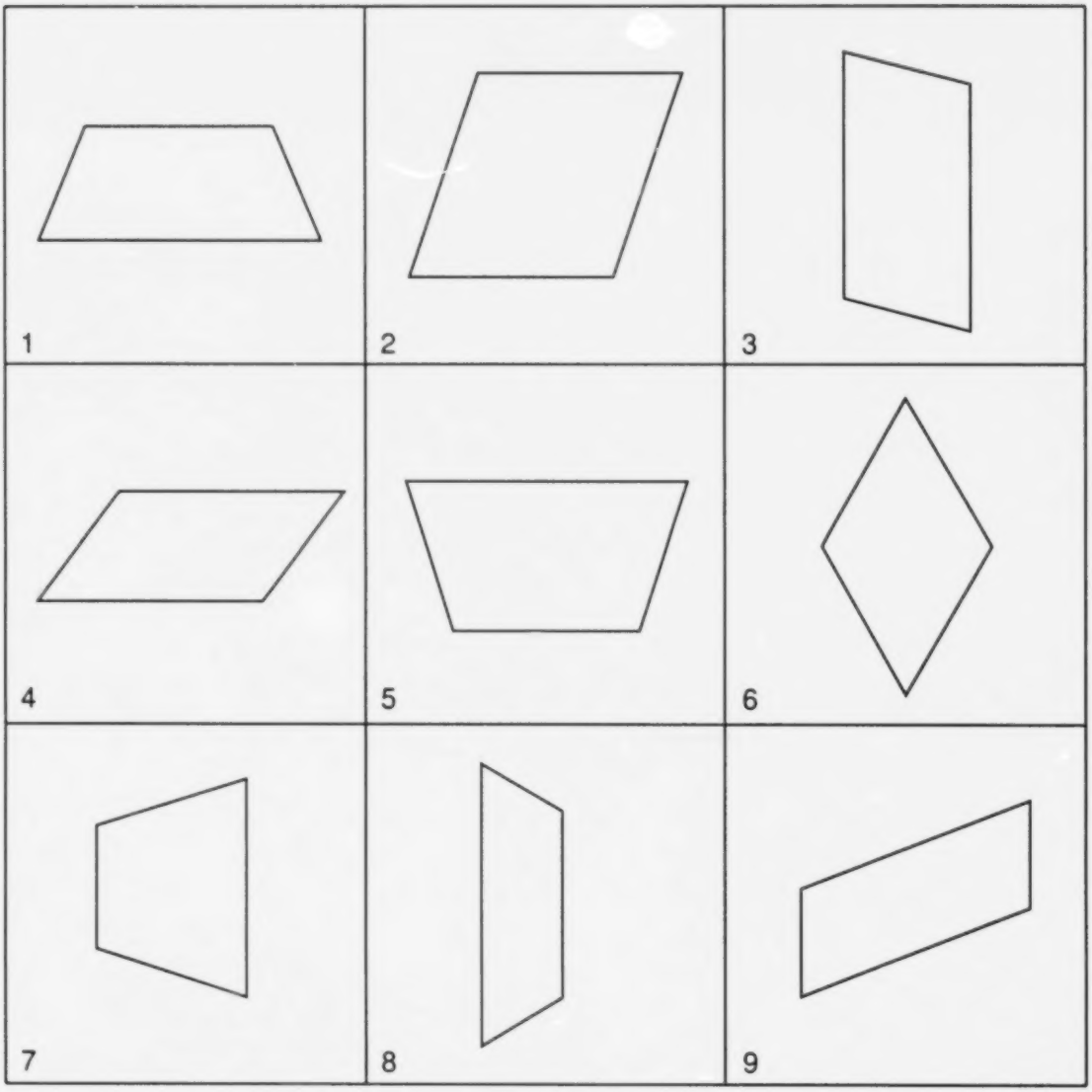


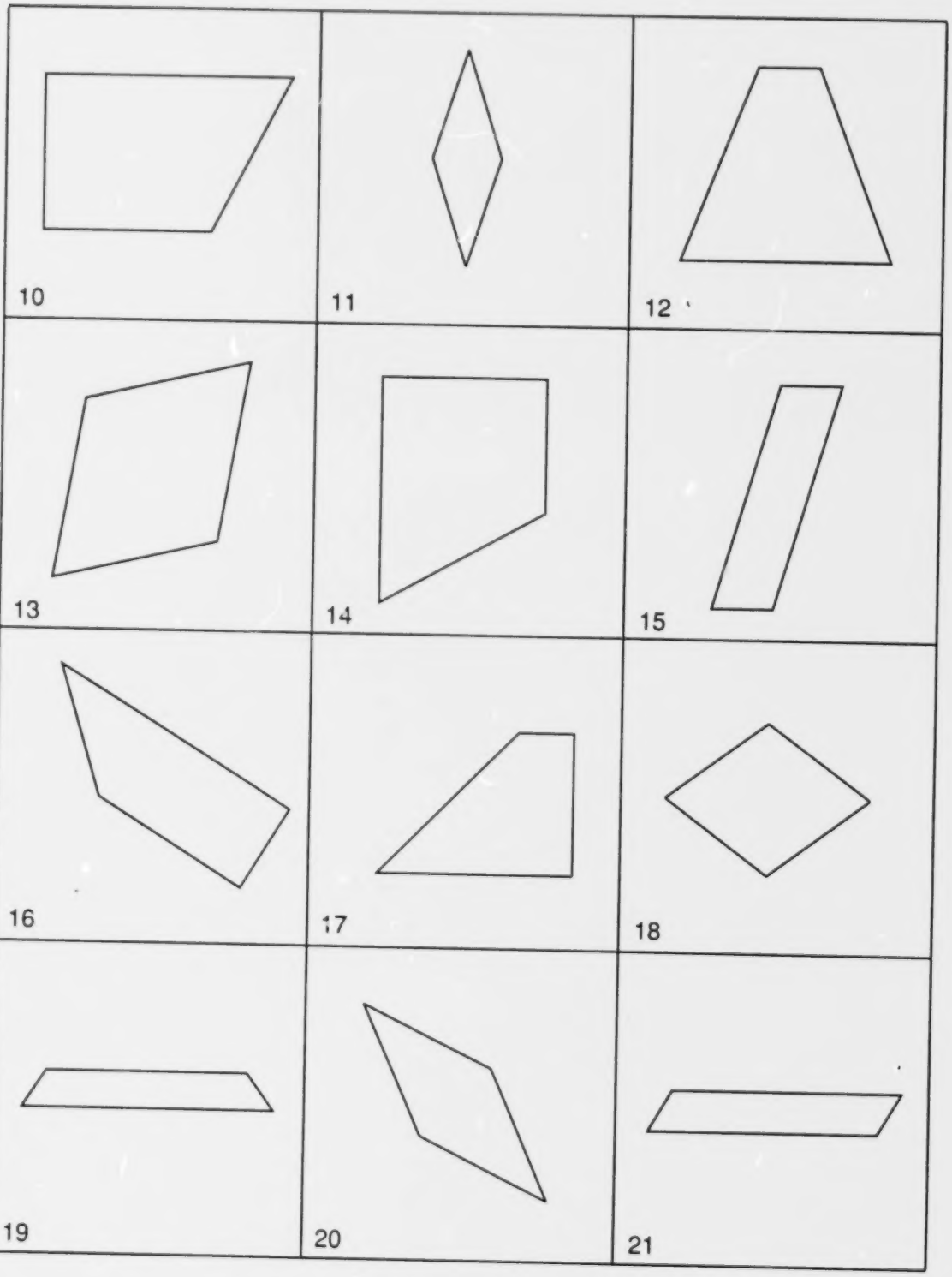
A quadrilateral with just two parallel sides is called a **trapezoid**. These quadrilaterals are trapezoids:



Exercise 7

Identify each quadrilateral below as follows: "parallelogram," "rhombus" or "trapezoid."

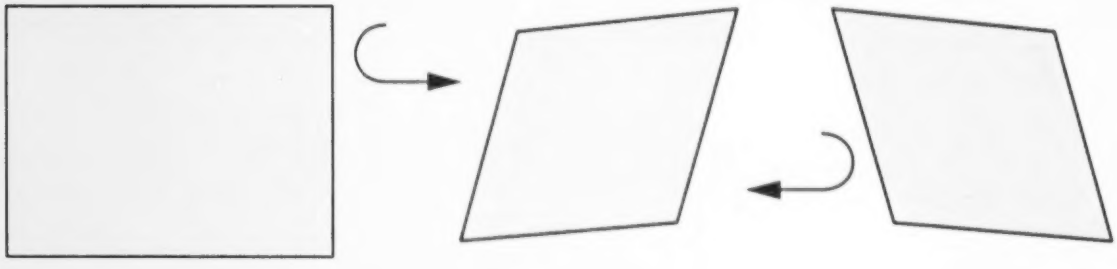



10
11
12
13
14
15
16
17
18
19
20
21

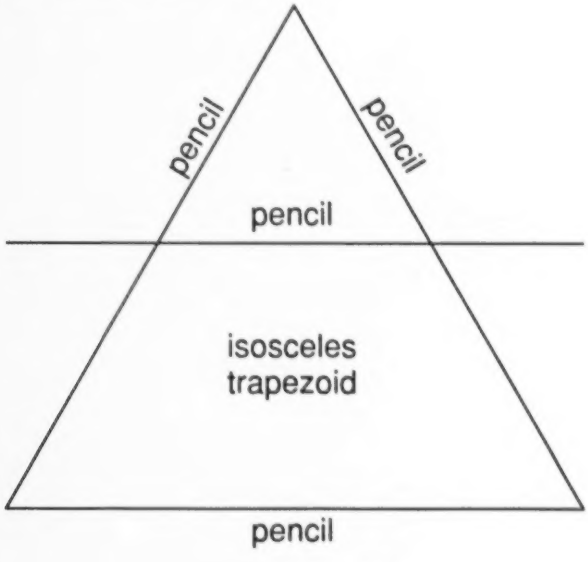
Treasure Hunt

Most quadrilateral objects, as you probably have gathered by now, are rectangular or square. You can, however, find a wide variety of parallelograms and rhombuses in the patterns of light that form on the floor and walls of your room as the sun shines in at a slant through the windows.

Remember also the exercise with shadows in Lesson 3. If you turn a rectangular object in various directions in front of a light, its shadow will change into different parallelograms. At certain points the parallelogram will be a rhombus.

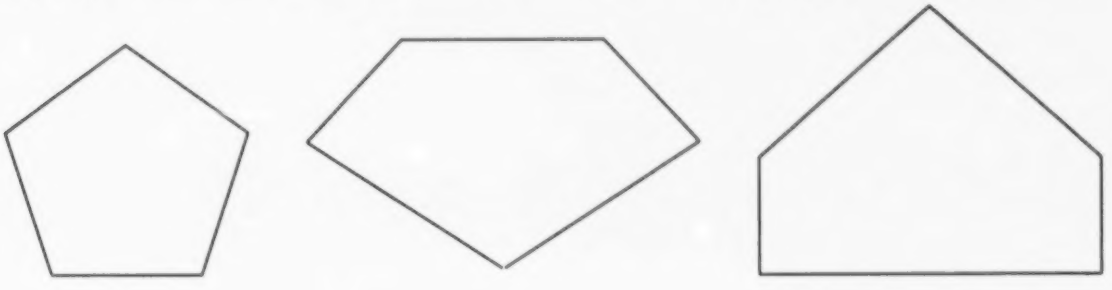


To fashion your own trapezoid, first make a triangle with three pencils, as you did in Lesson 5, and then lay a fourth pencil on top of the triangle so that it is parallel to one of the sides. The figure formed between the pencil and the side parallel to it will be a trapezoid. (A trapezoid whose non-parallel sides are equal is called an **isosceles trapezoid**.)

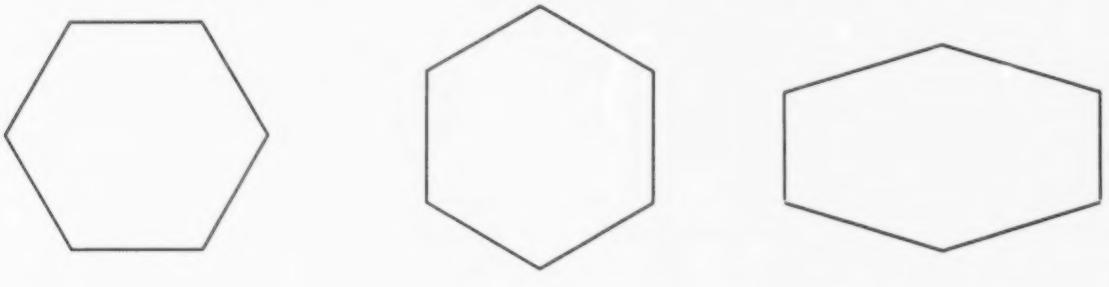


Lesson 8: Pentagons, Hexagons, and Octagons

A polygon with five sides is called a **pentagon**. These polygons are pentagons:



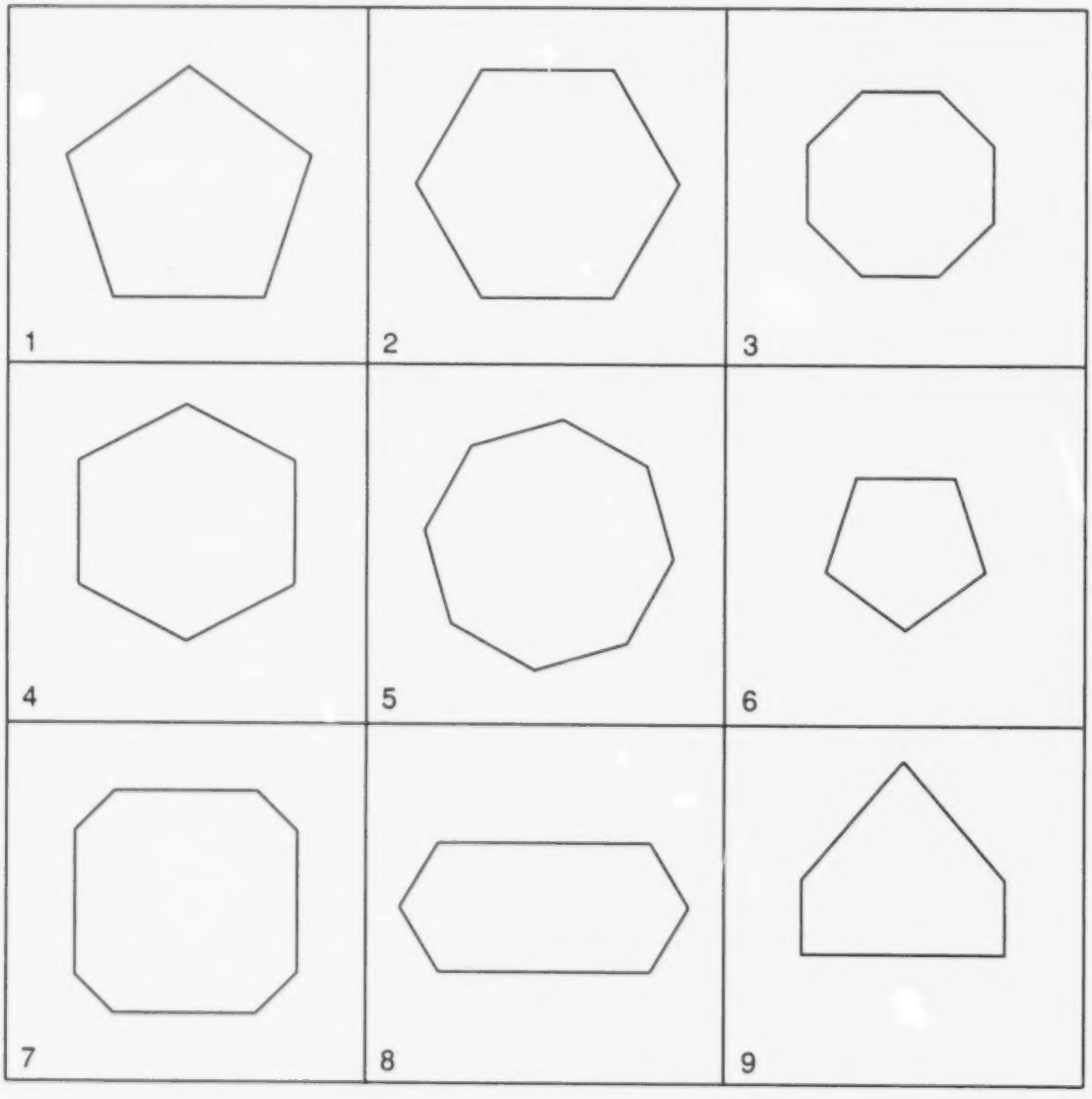
A polygon with six sides is called a **hexagon**. These polygons are hexagons:

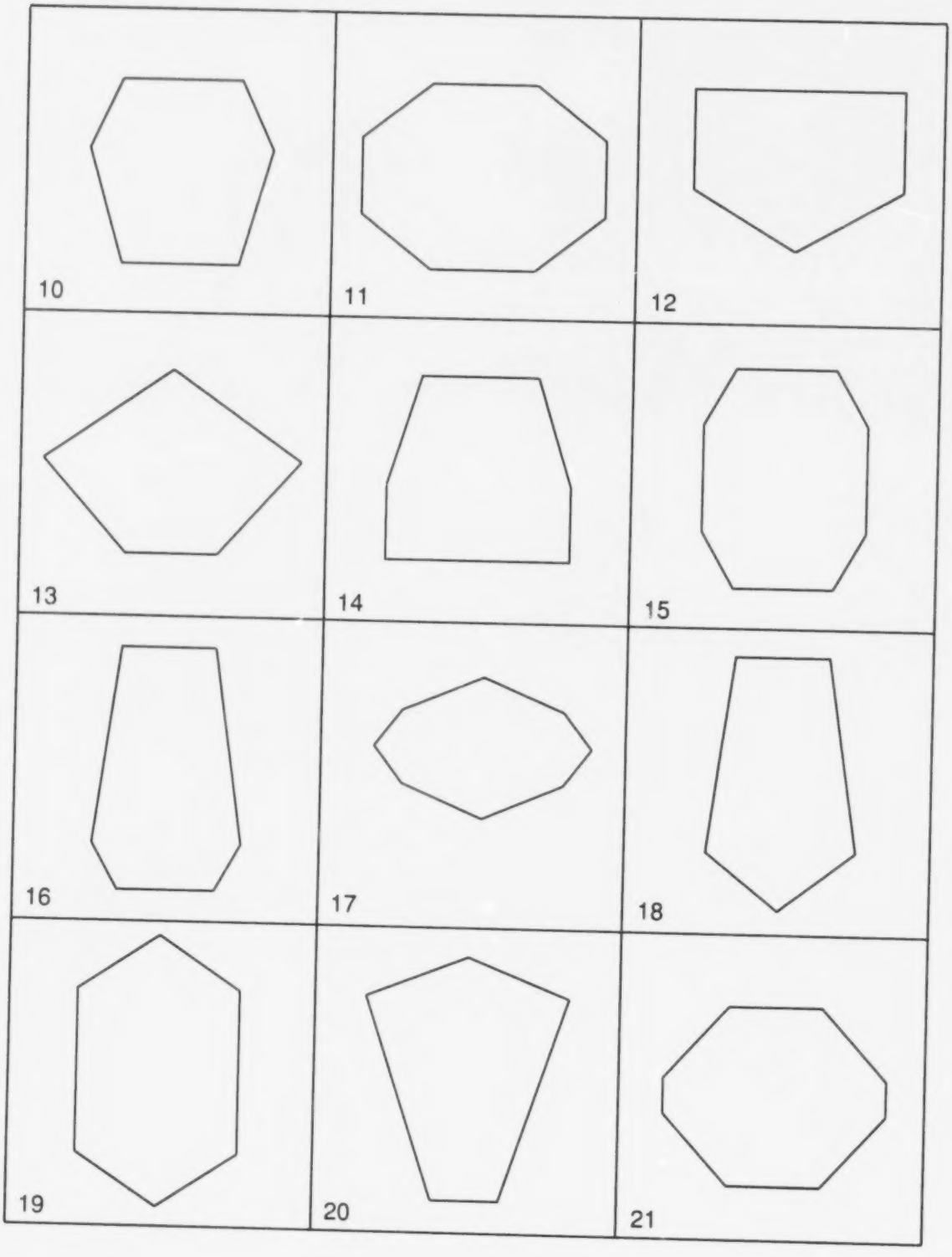


A polygon with eight sides is called an **octagon**. These polygons are octagons:

Exercise 8

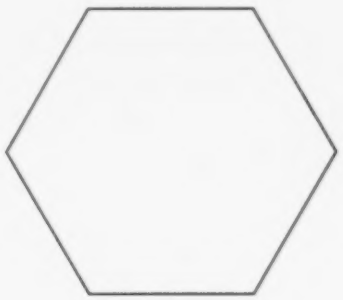
Identify each polygon in the exercise below as follows: "pentagon," "hexagon" or "octagon."




10
11
12
13
14
15
16
17
18
19
20
21

Treasure Hunt

Hexagonal figures are relatively common. Many floor tiles and decorative designs have hexagonal shapes. Most bolts and nuts and, of course, the wrenches that turn them are hexagonal.

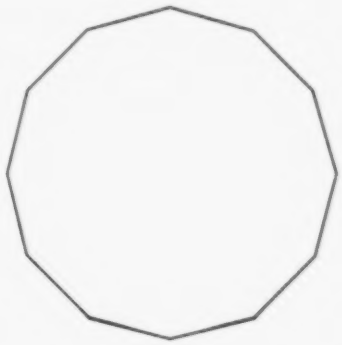


top view of
hexagonal bolt

If there are no octagons in your room, you can find plenty of them in the streets of your community. The most familiar of all traffic signs in the United States, the red stop sign, has an octagonal shape.

Pentagons are also relatively common. The shape of the large building where the U.S. Department of Defense is located, the logo of a popular American automobile, the design on the cover of soccer balls, and baseball home plates, for instance, are pentagonal.

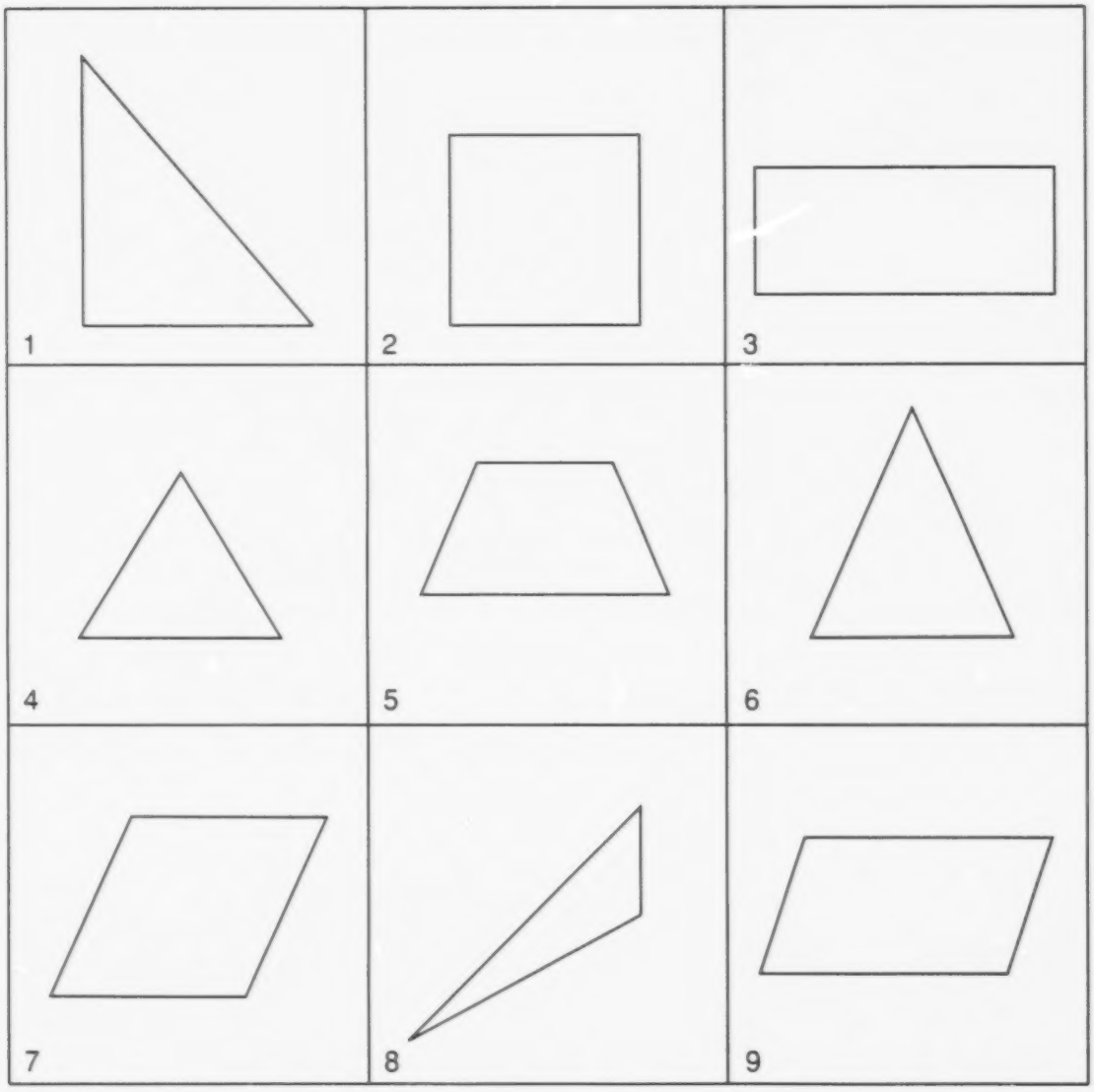
Note that the more sides you add to a polygon without changing its **area** (the size of the space inside), the more it looks like a circle. Consider, for example, this polygon with twelve sides, a **dodecagon**.

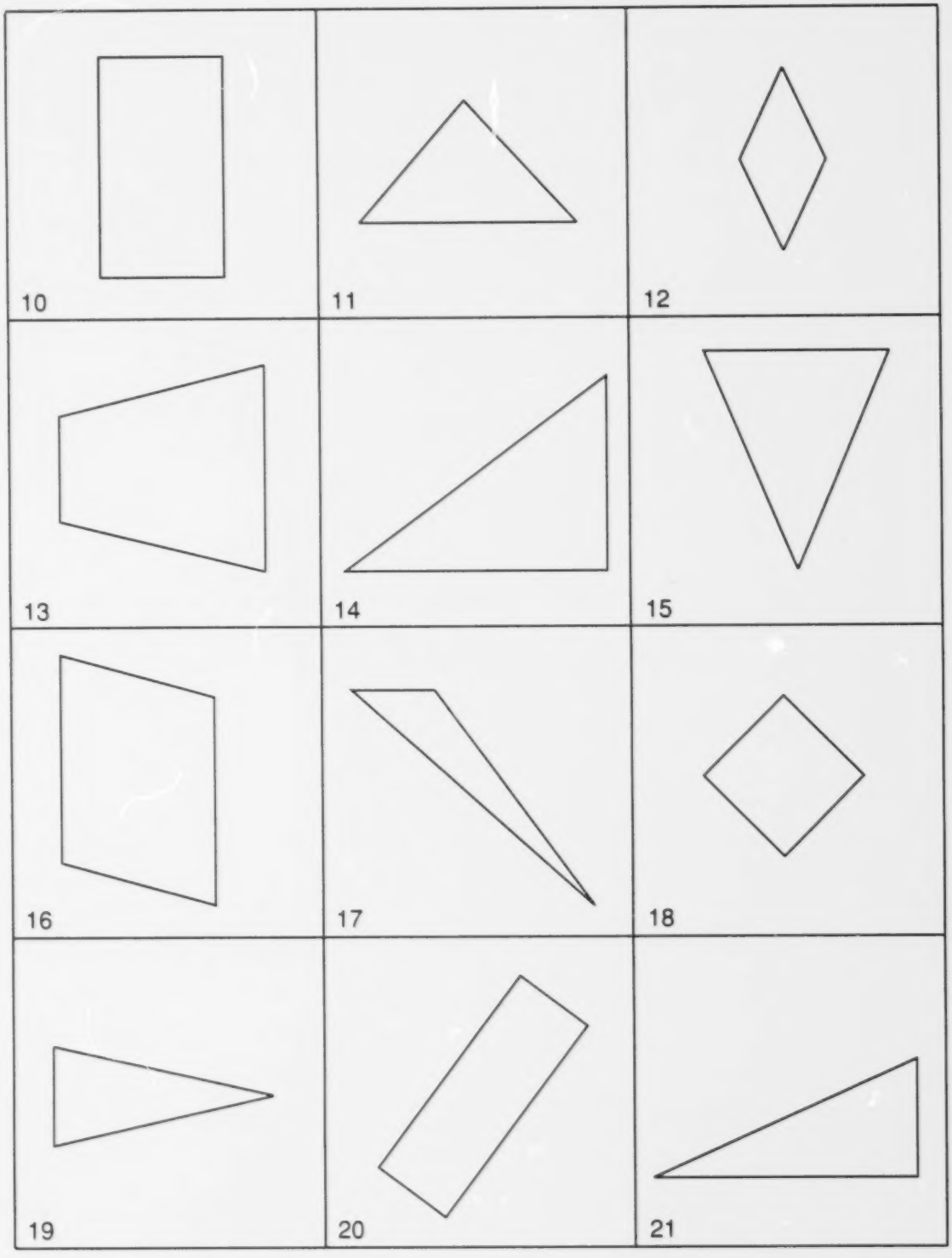


41

Review Exercise B

Identify the polygons below. If the polygon is a right triangle, indicate whether it is an isosceles right triangle or a scalene right triangle.

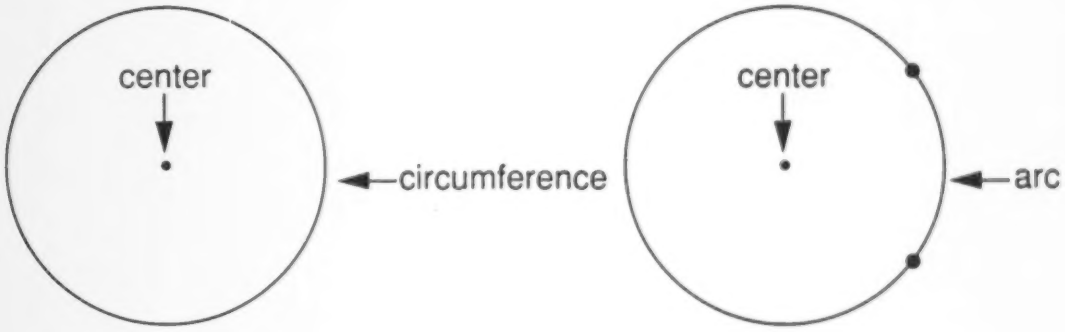



10
11
12
13
14
15
16
17
18
19
20
21

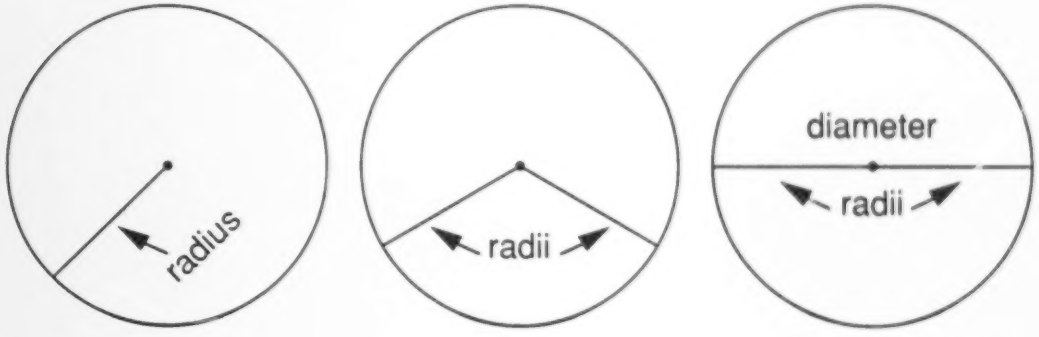
LESSON 9: CIRCLES

All the figures that we have studied up to this point have been polygons – figures bounded by straight lines only. Now we shall introduce a very important non-polygon, the **circle**.

A circle is a closed curved line all of whose points are **equidistant** (the same distance) from the **center**. The closed curved line that forms the circle is its **circumference**. A part of the circumference is called an **arc**.

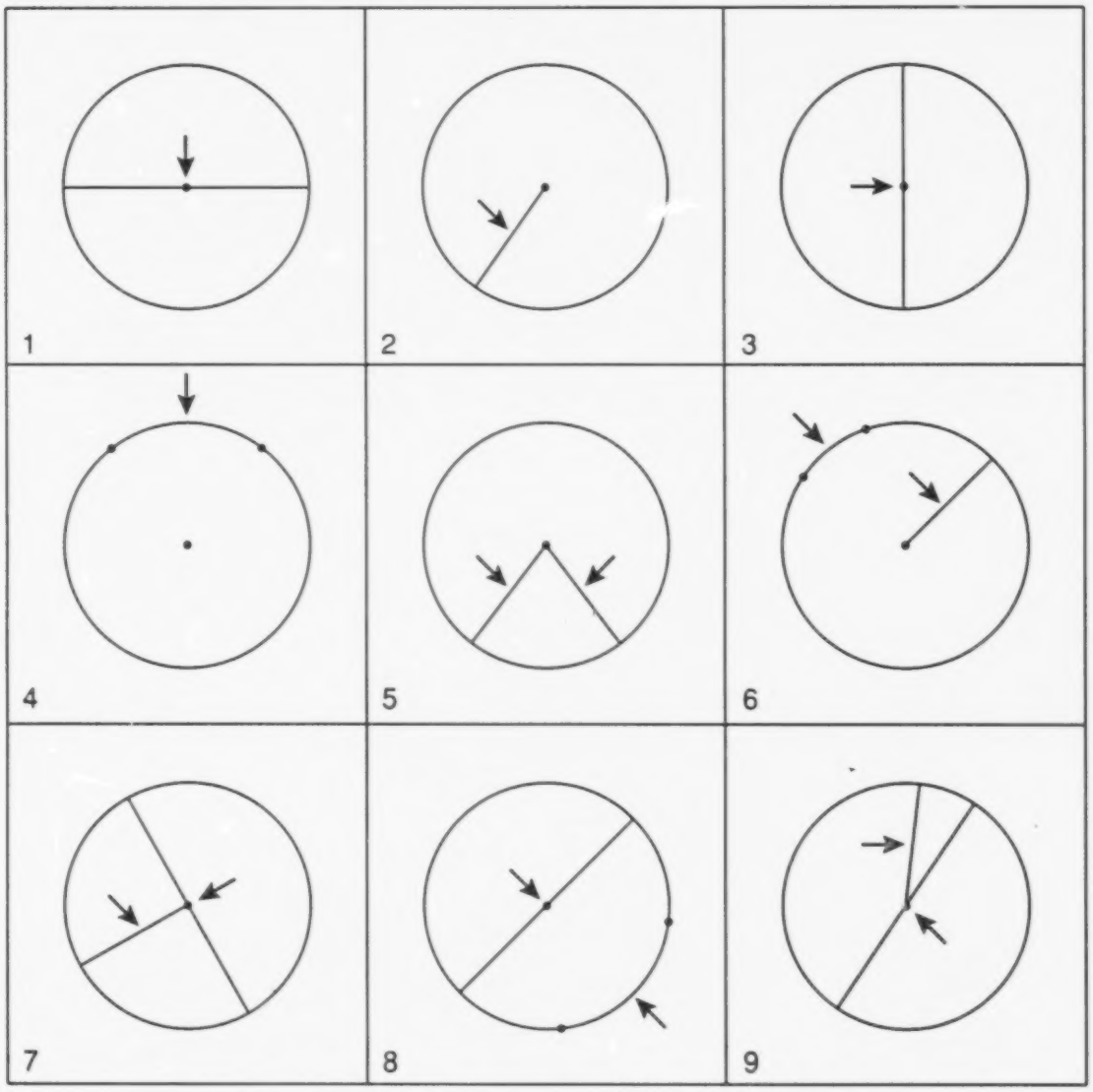


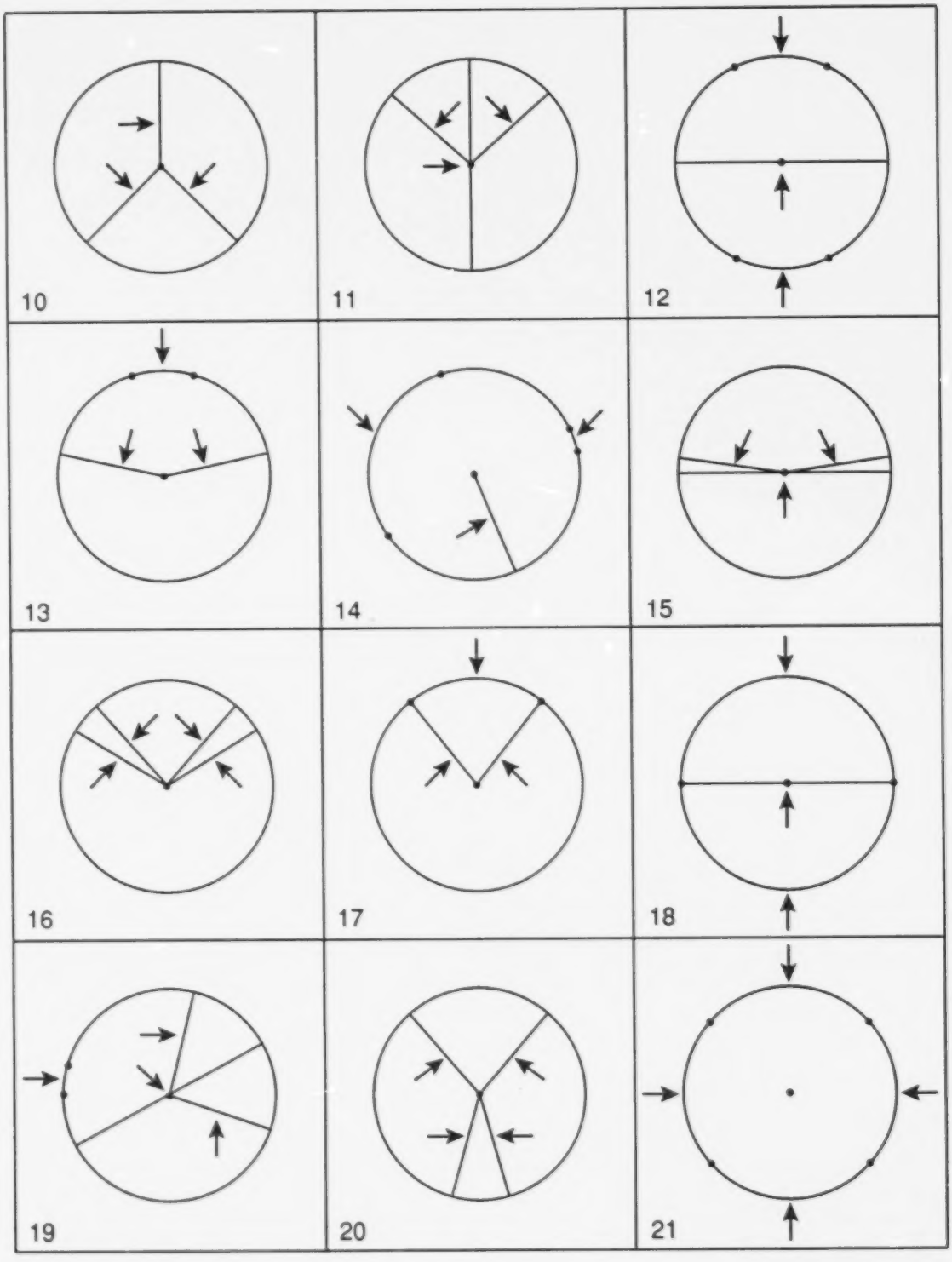
A straight line from the center of the circle to any point on the circumference is called the **radius**. The plural of radius is **radii**. Since all points on the circumference are equidistant from the center, all radii are of equal length. A straight line passing through the center from one point on the circumference to another is called the **diameter**. The diameter, as you will note, consists of two radii laid end to end in a straight line.



Exercise 9

Identify the straight and curved lines indicated by arrows in the circles below as "radius," "diameter," "arc," "one arc and two radii," etc. (Note to the teacher: geometric points are part of the line on which they lie: they do not stand out from the rest of the line. The dots in these drawings are magnified illustrations of points.)

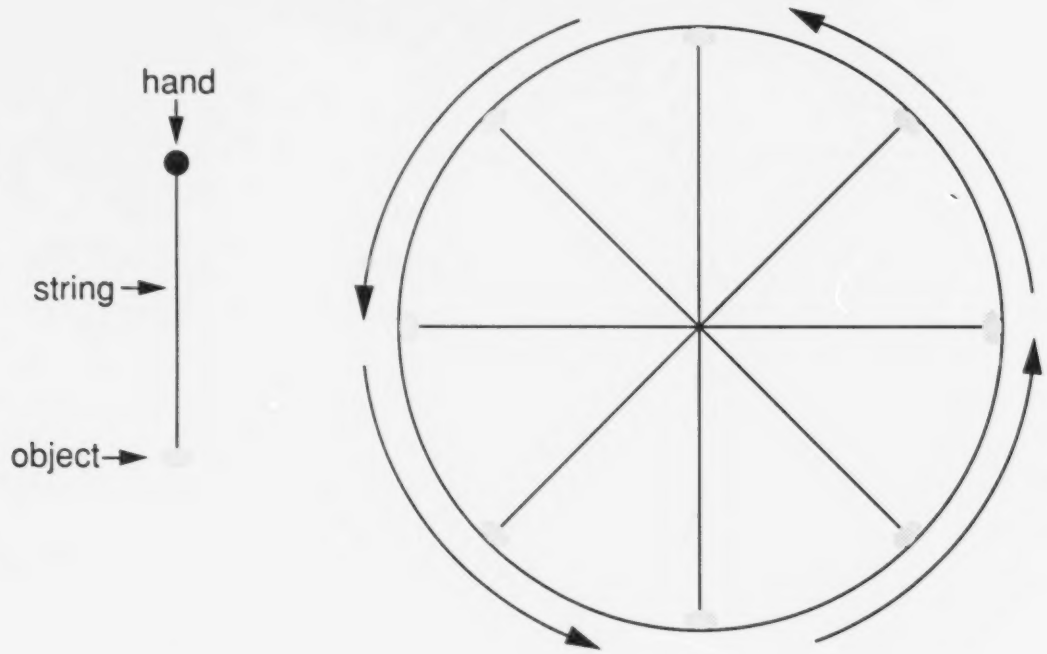



10
11
12
13
14
15
16
17
18
19
20
21

Treasure Hunt

Circles are just as common as rectangles. Look around your room and you will find all kinds of objects with circular outlines or edges: coins, cups, saucers, cans, door knobs, dials, rings, rolls of tape, thumb tacks, the holes in notebook paper, clocks, and so forth.

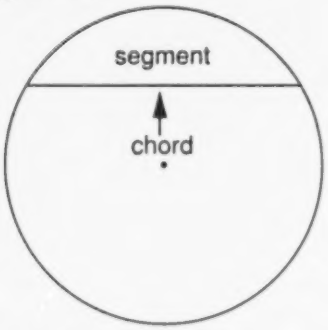
But to better learn about the parts and structure of a circle, generate your own by tying a small object to a string and twirling it in front of you. Your hand will be the center of the circle, the string its radius, the object a point in the circumference, and the trajectory of the object the circumference. The faster you twirl, the clearer the shape of the circle will appear.

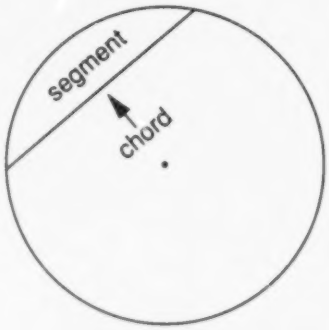


Be careful, though, not to hurt yourself or anyone around you. For your weighted object, use something soft, like a rubber top or an eraser. Tie it securely and stand safely away from others in your group.

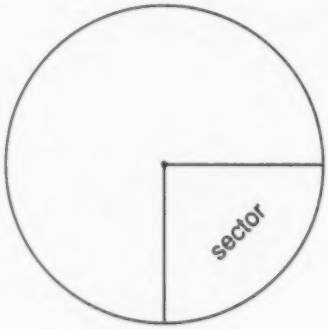
Lesson 10: Chords, Segments, Sectors, and Semicircles

A straight line joining two points on the circumference of a circle is called a **chord**, and the area bounded by a chord and the arc between its end points is called a **segment**.

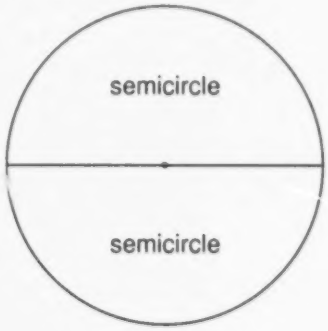




The area bounded by two radii and the arc between their points is called a **sector**.

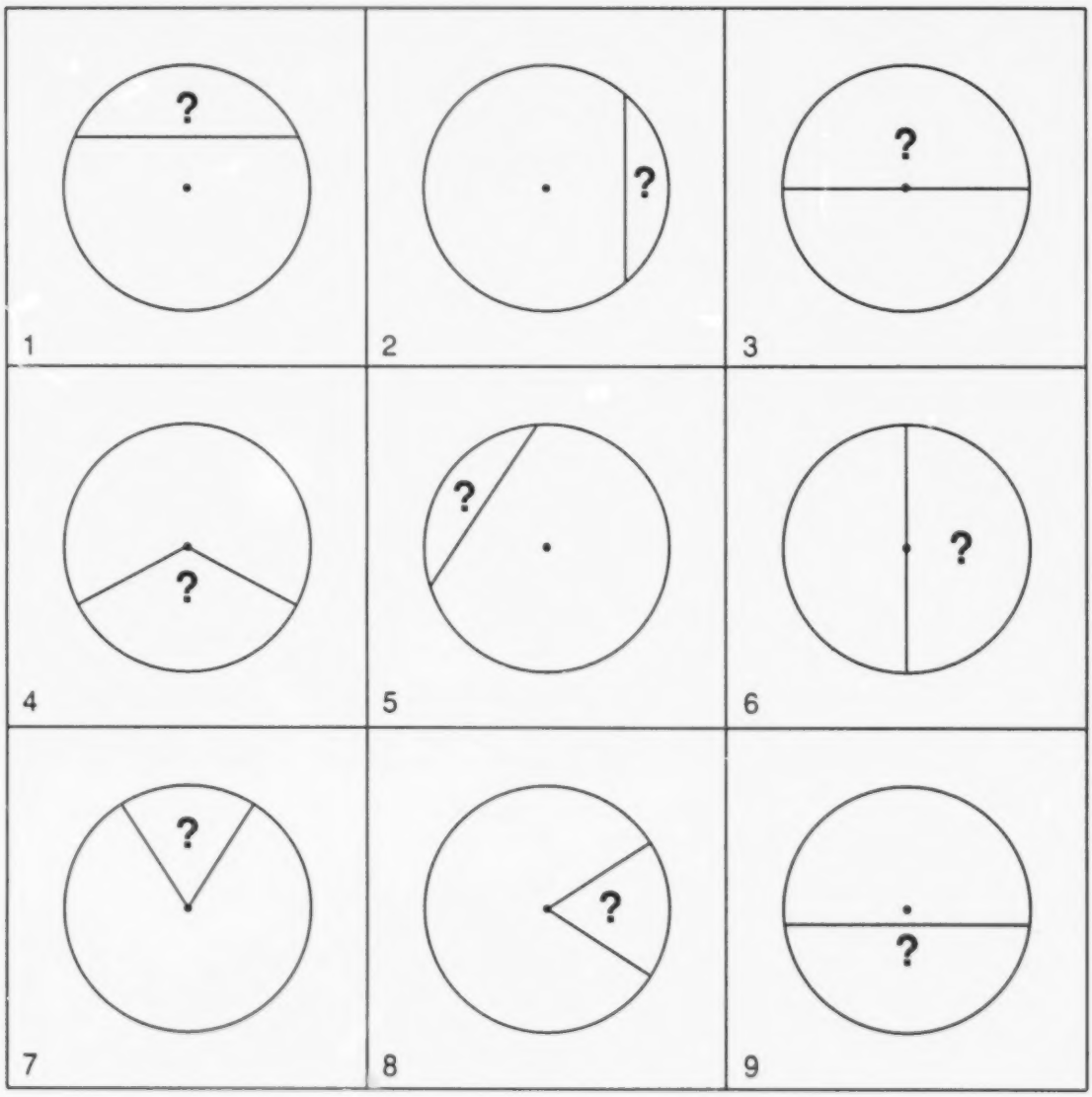


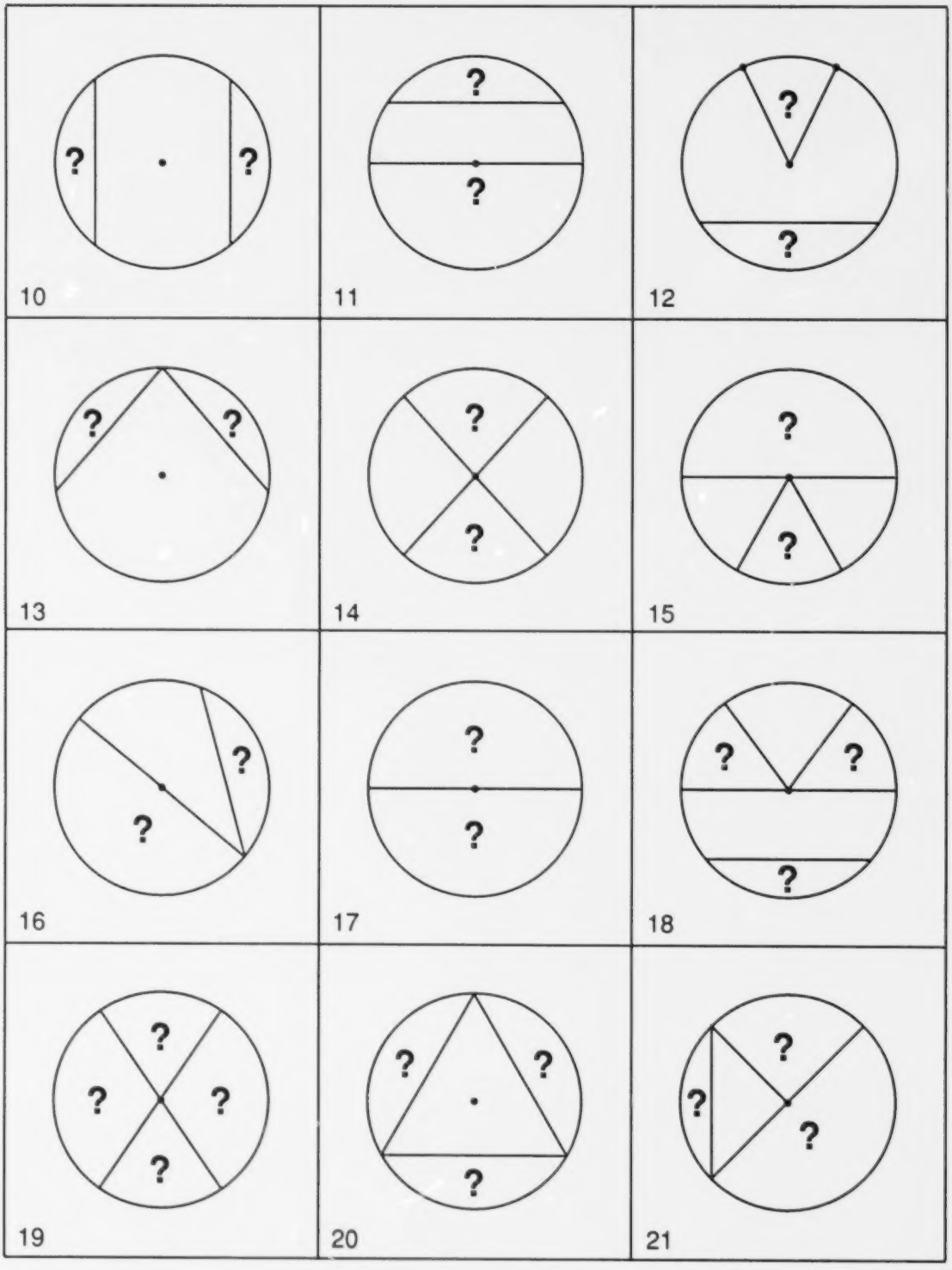
The area bounded by the diameter and the arc between its end points is called a **semicircle**, which means half a circle.



Exercise 10

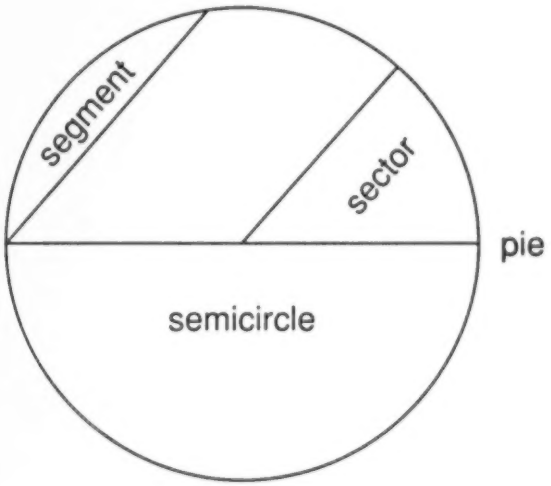
Identify the areas with a question mark in each circle below as "segment," "sector," "semicircle," "one segment and two sectors," etc. (Note that, by definition, a semicircle is a special kind of segment and also is a special kind of sector.)



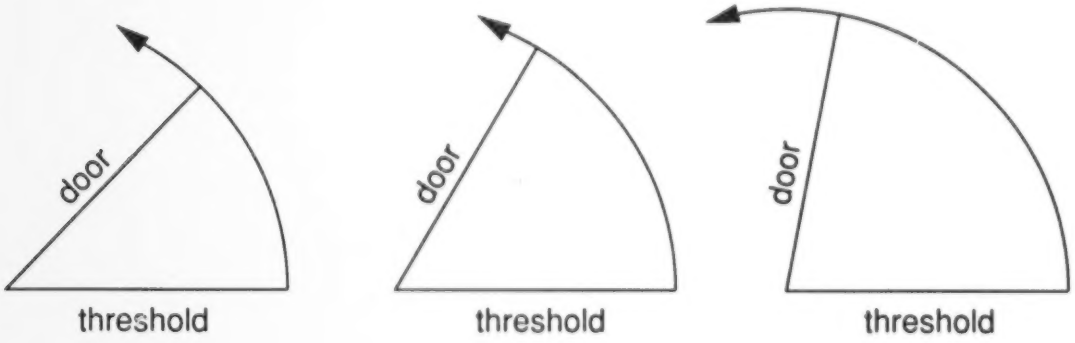

10
11
12
13
14
15
16
17
18
19
20
21

Treasure Hunt

Treat yourself to a pie–or, at least, recall the last one you had–and pretend that it is a perfect circle. If you cut your piece the usual way, from the center to the circumference, you will be eating a sector. If you slice off a piece horizontally, vertically or diagonally, you will be eating a segment. And if you are real hungry and cut your piece right down the middle, then you will be putting away an entire semicircle!

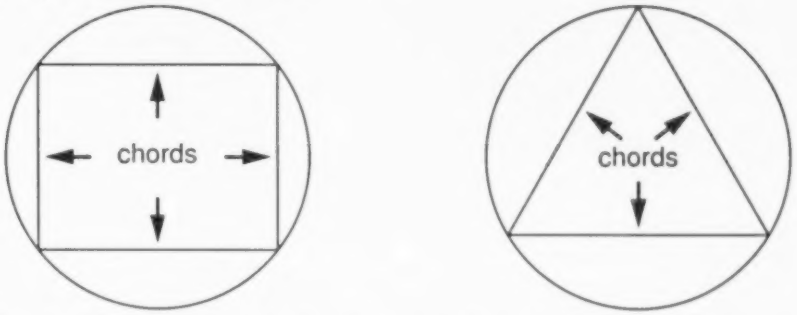


After you are done with the pie, repeat the exercise you did with the door in Lesson 2; but this time, instead of viewing the threshold and the bottom edge of the door as the sides of an angle, regard them as the radii of a circle. Then note how the arc and sector they form change as the door opens and closes.

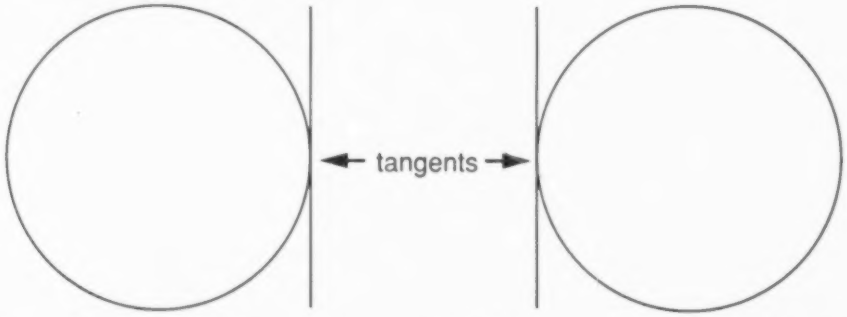


Lesson 11: Inscribed Polygons, Tangent Lines, and Circumscribed Polygons

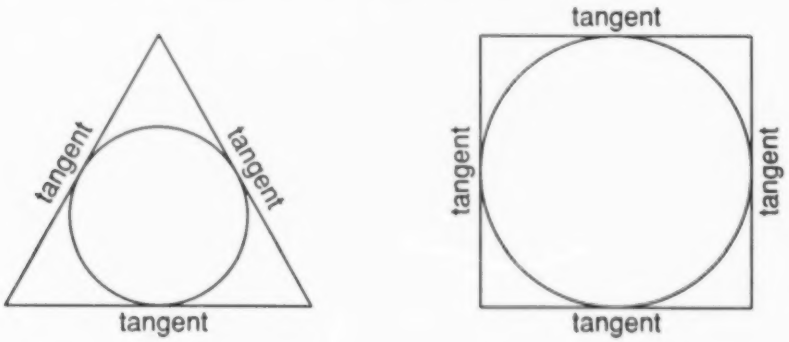
A polygon whose sides are chords of a circle is said to be **inscribed**. The following polygons are inscribed.



Any straight line outside a circle that touches the circumference at one and only one point is called a **tangent**.

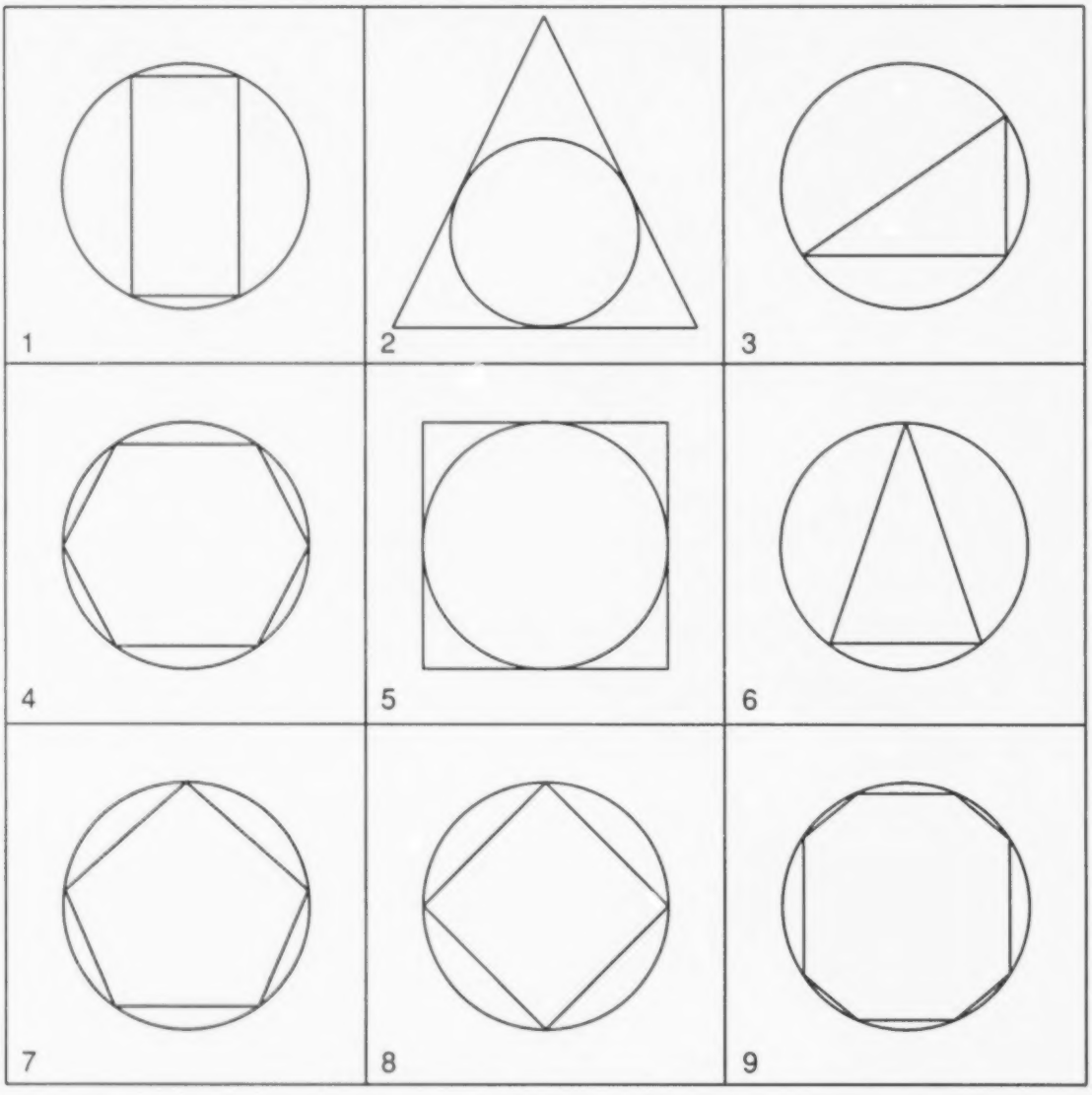


A polygon whose sides are tangents to the same circle is said to be **circumscribed**. The polygons below are circumscribed:

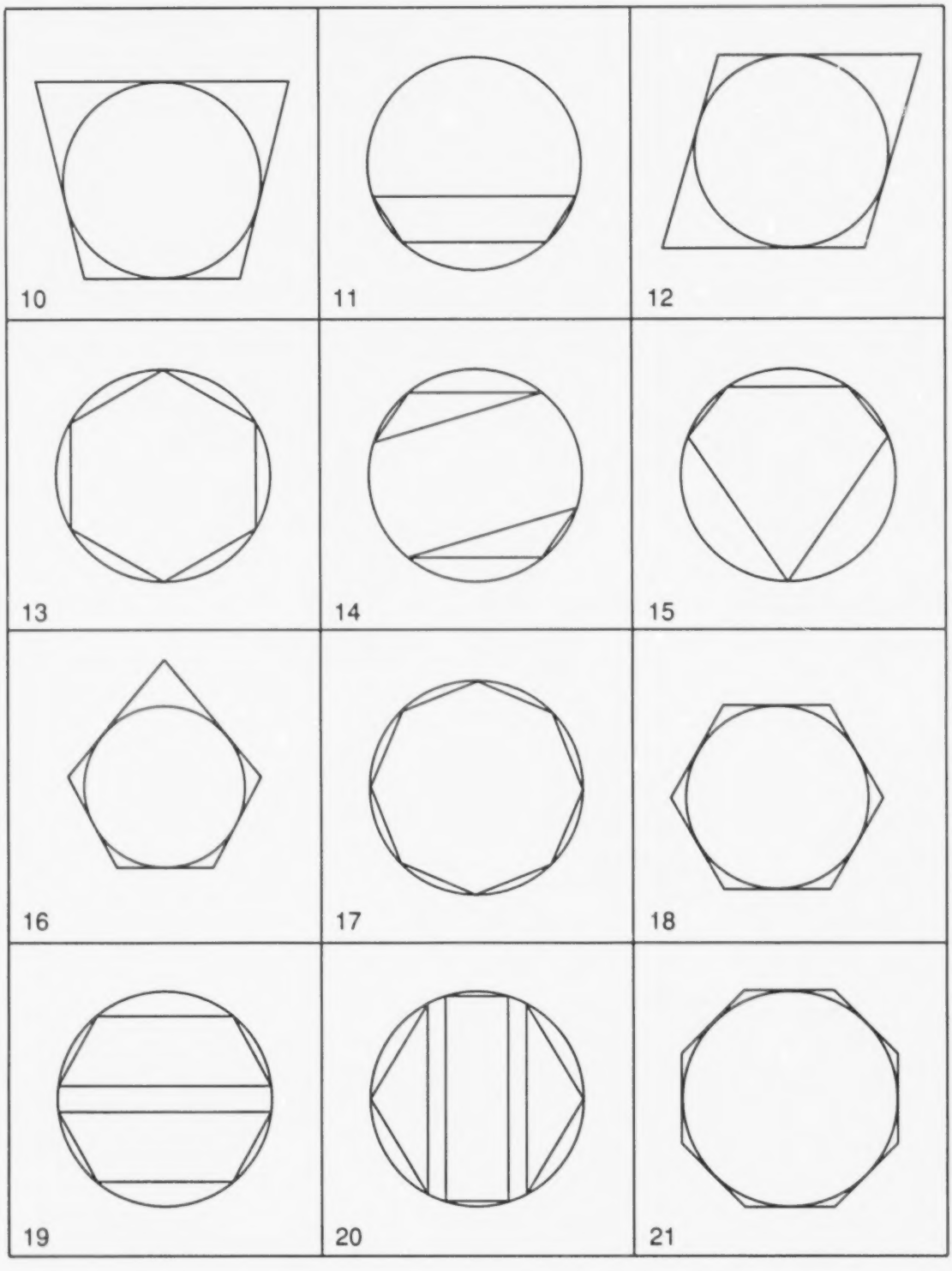


Exercise 11

Describe each figure below in detail; indicate, for example, "inscribed isosceles triangle," "circumscribed octagon," "two inscribed scalene triangles," "circumscribed trapezoid," etc.



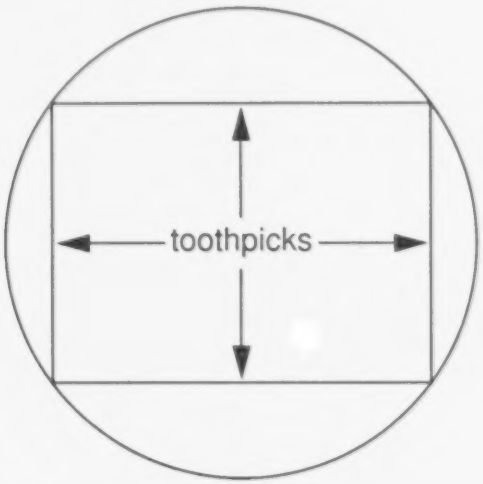
46



47

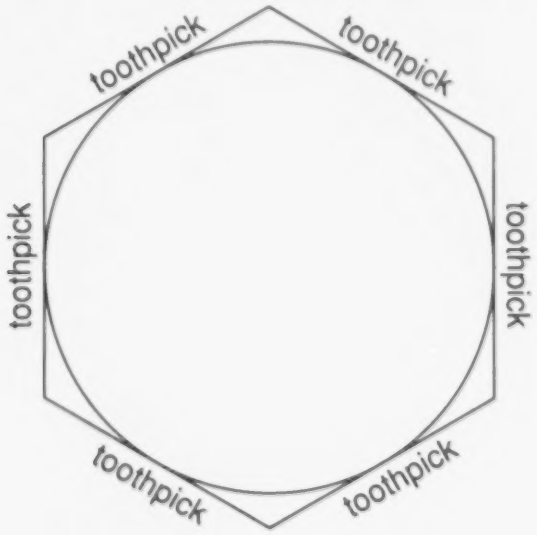
Treasure Hunt

You have learned from your previous treasure hunts that most geometric figures can be easily created with objects or materials close at hand. One easy way to fashion approximations of inscribed polygons is to place toothpicks end to end inside a circular object, so that the abutting ends are touching the curve of the object. You will probably have to break some of the toothpicks to make them fit.



inscribed rectangle

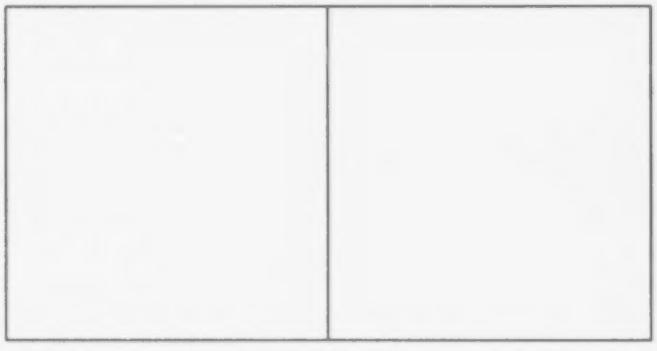
To fashion a circumscribed polygon place the toothpicks outside the object. Note that if you use the same objects and toothpicks you used for your inscribed polygon, you will need some extra toothpicks.



circumscribed hexagon

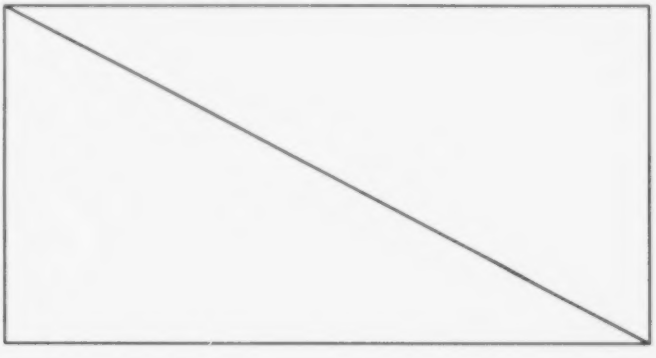
Lesson 12: Congruent Polygons, Diagonals, and Complex Figures

In Lesson 10 we learned that a circle can be broken down into simpler figures–segments, sectors, semicircles. If we put these figures back together, they will form a circle. In other words, they are at once the pieces and building blocks of a circle. Let us now expand on this idea by noting how polygons can form and be formed by other polygons. We might say, for instance, that the rectangle below is divided into two identical or **congruent** squares; or, if we prefer, that the two congruent squares make up the rectangle.



congruent squares

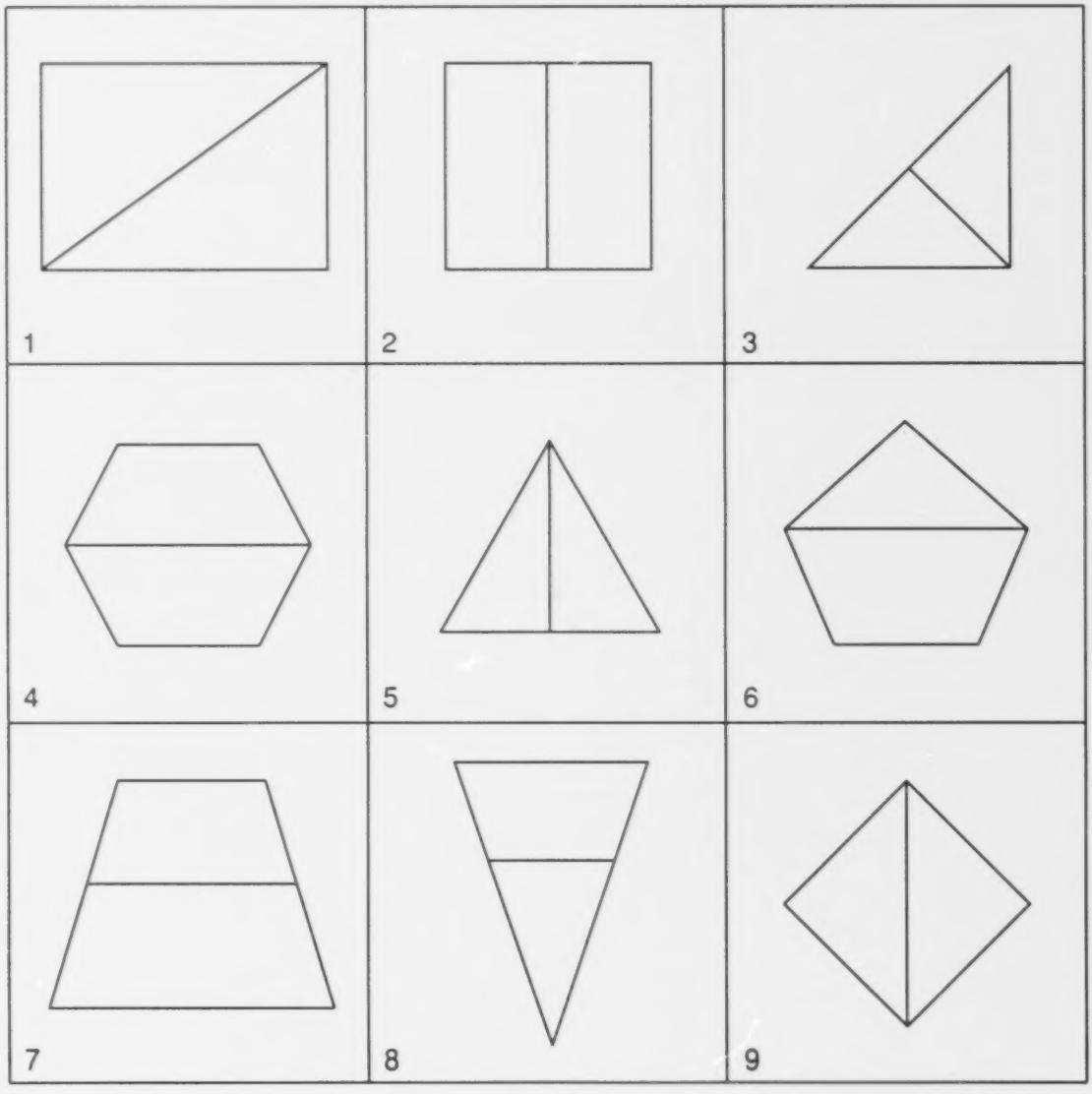
A straight line joining the vertices of a polygon is called a **diagonal**. The rectangle below is divided by a diagonal into two congruent right triangles; or, we could say that the two congruent right triangles are joined at their hypotenuse (recall Lesson 4) to form a rectangle. So the line inside the figure may be regarded as either the diagonal of a rectangle or the common hypotenuse of two congruent right triangles.

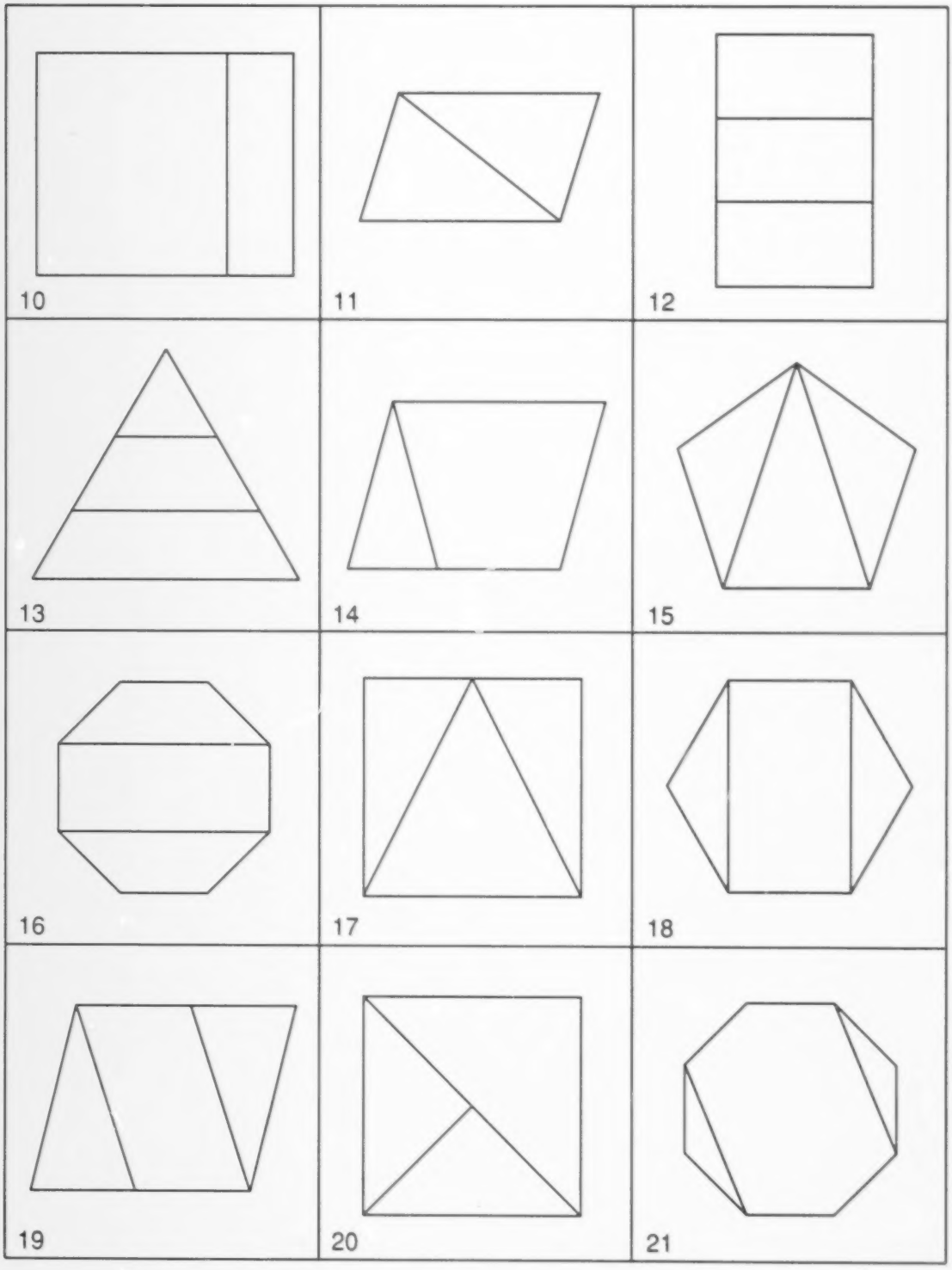


congruent right triangles

Exercise 12

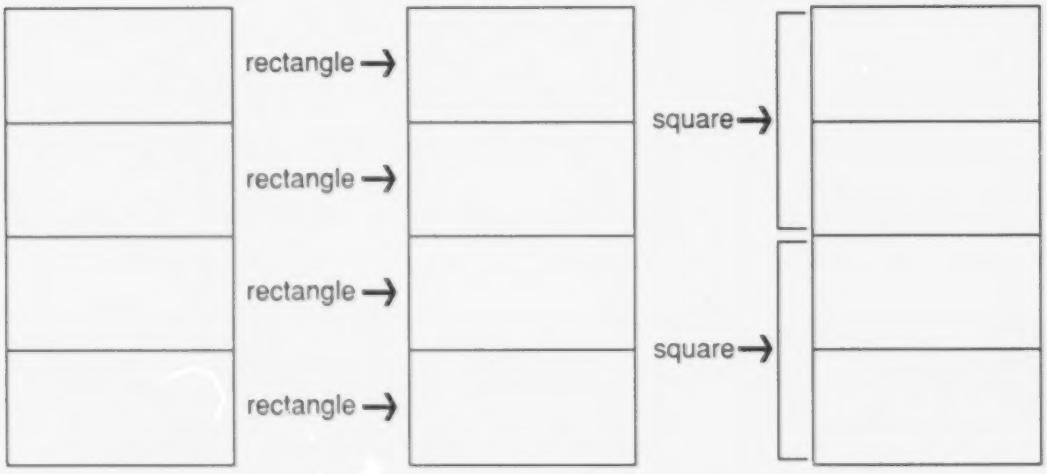
Describe each figure below in detail by first naming the larger figure and then the smaller, contained figures; indicate, for example, "hexagon: two congruent isosceles triangles, one rectangle."



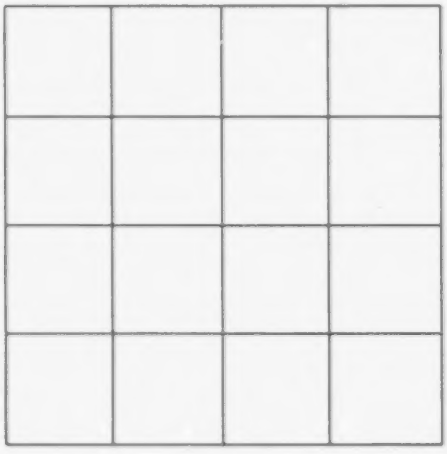

10
11
12
13
14
15
16
17
18
19
20
21

Treasure Hunt

The more complex a figure, the more ways it can be described. Consider, for instance, the outline of the bookcase below. You could describe it as a rectangle made up of smaller congruent rectangles; or, if you wish, as a rectangle made up of two congruent squares each consisting of two congruent rectangles. Can you find other combinations of figures in it?



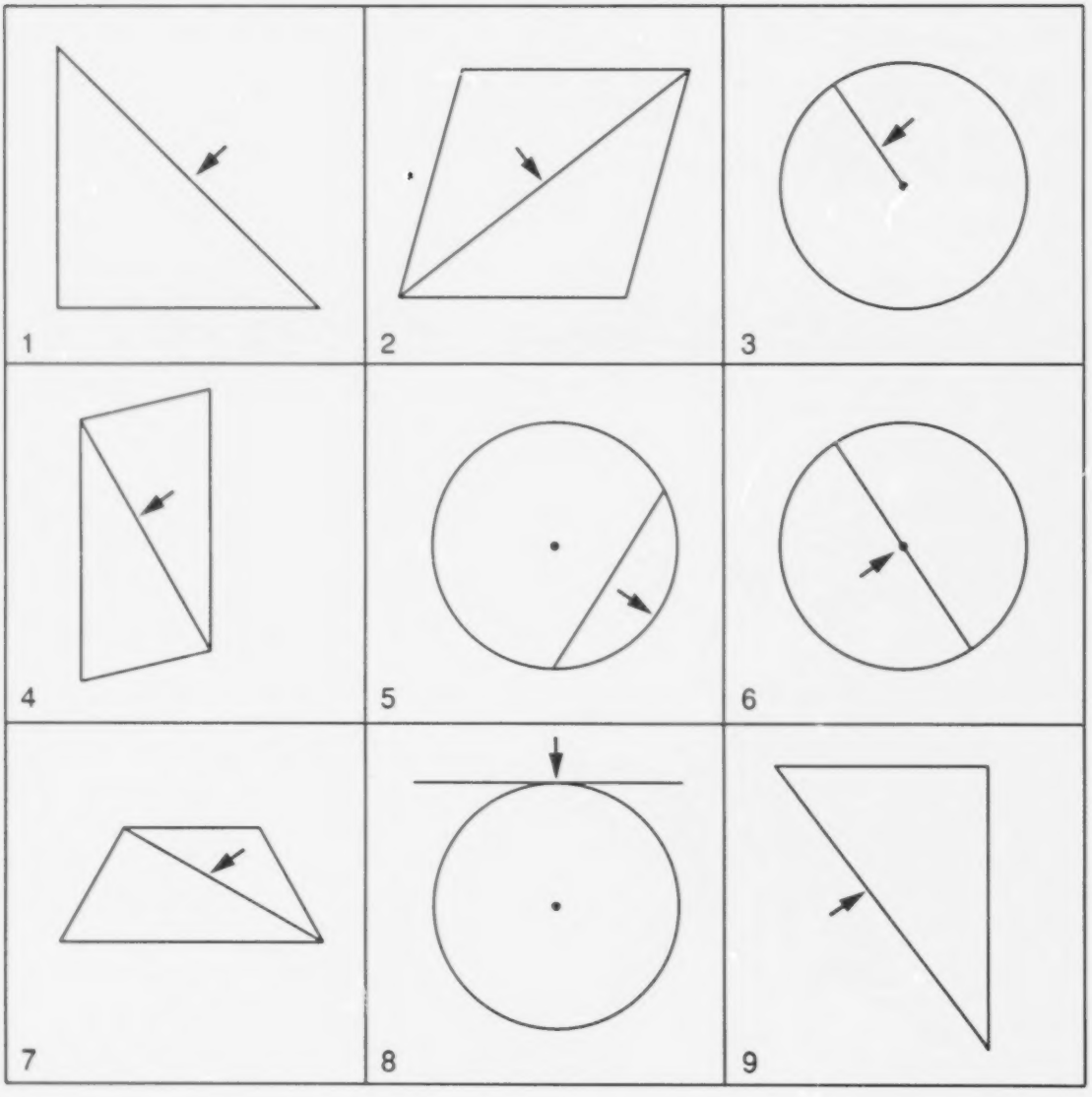
Now see how many different ways you can describe the outline of this window.

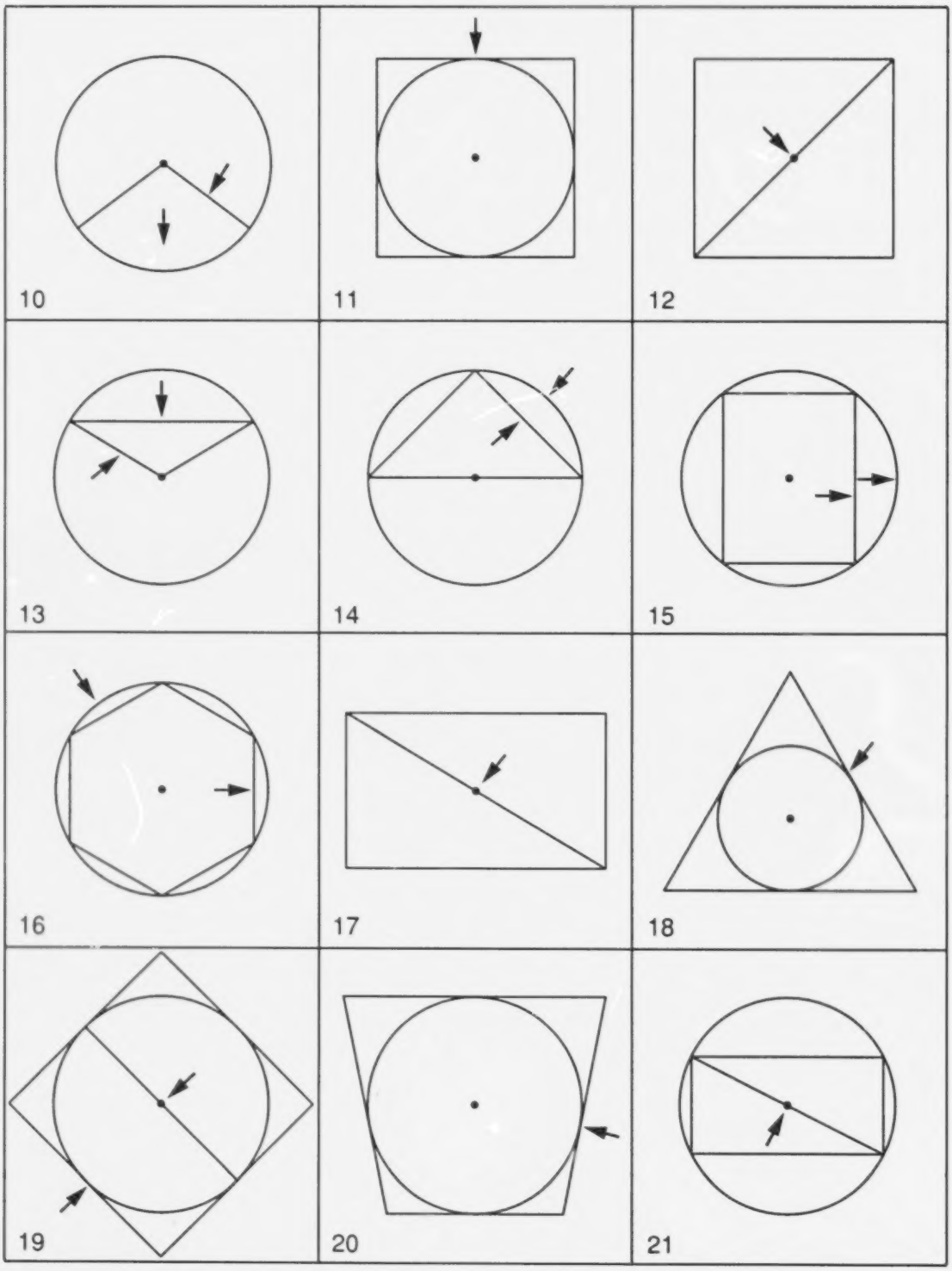


With the knowledge you have gained from these lessons and treasure hunts, you are now prepared to go on discovering plane geometry in the world around you.

Review Exercise C

Identify the lines marked by an arrow.




10
11
12
13
14
15
16
17
18
19
20
21

Final Comprehension Exercise

Identify the figures, angles, or lines defined below.

1. A polygon with three sides–
2. The closed curved line that forms a circle–
3. A polygon with eight sides–
4. A straight line from the center of a circle to a point on its circumference–
5. An angle greater than a right angle but not so great that its sides open up to form a straight line–
6. The longest side of a right triangle–
7. A polygon with four sides–
8. A straight line connecting two points on the circumference of a circle–
9. A straight line connecting two points on the circumference of a circle and passing through the center–
10. Two straight lines that meet to form a right angle–
11. A quadrilateral all of whose angles are right angles–
12. A quadrilateral all of whose angles are right angles and all of whose sides are equal–
13. A polygon with six sides–
14. The exact point where two straight lines meet to form an angle–
15. A triangle with two equal sides–
16. A quadrilateral whose opposite sides are parallel–
17. Half of a circle–
18. A triangle whose three sides are unequal–
19. An angle smaller than a right angle but not so small that its sides come together–

20. A curved line between two points on the circumference of a circle–
21. Straight lines on the same plane that never meet no matter how far they are extended–
22. A quadrilateral with only two parallel sides–
23. A triangle all of whose sides are equal–
24. A polygon with five sides–
25. Identical figures–
26. A line outside a circle touching the circumference at one and only one point–
27. A closed plane figure formed with straight lines only–
28. A polygon whose sides are chords of a circle–
29. The area in a circle bounded by two radii and the arc between the end points of the radii–
30. A quadrilateral whose sides are equal and parallel–
31. A polygon whose sides are tangents of a circle–
32. An area in a circle bounded by a chord and the arc between the end points of the chord–

ANSWERS

Lesson 1: Perpendicular and Parallel Lines

1. perpendicular 2. neither 3. parallel 4. parallel 5. perpendicular 6. neither 7. perpendicular 8. parallel 9. neither 10. parallel 11. perpendicular 12. perpendicular 13. neither 14. parallel 15. perpendicular 16. perpendicular 17. neither 18. parallel 19. parallel 20. neither 21. perpendicular

Lesson 2: Right, Acute, and Obtuse Angles

1. right 2. acute 3. right 4. obtuse 5. acute 6. right 7. obtuse 8. right 9. obtuse 10. acute 11. right 12. obtuse 13. right 14. acute 15. obtuse 16. acute 17. obtuse 18. right 19. acute 20. right 21. right

Lesson 3: Polygons

1. not a polygon 2. not a polygon 3. polygon 4. polygon 5. not a polygon 6. polygon 7. not a polygon 8. polygon 9. polygon 10. not a polygon 11. polygon 12. polygon 13. not a polygon 14. not a polygon 15. polygon 16. polygon 17. not a polygon 18. polygon 19. not a polygon 20. polygon 21. not a polygon

Lesson 4: Right Triangles

1. other triangle 2. right triangle 3. other triangle 4. right triangle 5. right triangle 6. other triangle 7. right triangle 8. other triangle 9. right triangle 10. right triangle 11. right triangle 12. other triangle 13. other triangle 14. right triangle 15. other triangle 16. right triangle 17. other triangle 18. right triangle 19. other triangle 20. right triangle 21. other triangle

Lesson 5: Scalene, Isosceles, and Equilateral Triangles

1. equilateral 2. scalene 3. isosceles 4. isosceles 5. equilateral 6. scalene 7. equilateral 8. isosceles 9. scalene 10. isosceles 11. equilateral 12. scalene 13. equilateral 14. isosceles 15. scalene 16. equilateral 17. scalene 18. isosceles 19. equilateral 20. scalene 21. isosceles

Review Exercise A

1. right 2. acute 3. right 4. right 5. acute 6. obtuse 7. acute 8. acute 9. obtuse 10. right 11. acute 12. acute 13. obtuse 14. right 15. acute 16. right 17. obtuse 18. acute 19. right 20. obtuse 21. acute

Lesson 6: Quadrilaterals, Rectangles, and Squares

1. square 2. rectangle 3. rectangle 4. other quadrilateral 5. square 6. rectangle 7. other quadrilateral 8. rectangle 9. other quadrilateral 10. other quadrilateral 11. square 12. other quadrilateral 13. rectangle 14. other quadrilateral 15. square 16. rectangle 17. other quadrilateral 18. other quadrilateral 19. rectangle 20. other quadrilateral 21. square

Lesson 7: Parallelograms, Rhombuses, and Trapezoids

1. trapezoid 2. rhombus 3. parallelogram 4. parallelogram 5. trapezoid 6. rhombus 7. trapezoid 8. trapezoid 9. parallelogram 10. trapezoid 11. rhombus 12. trapezoid 13. rhombus 14. trapezoid 15. parallelogram 16. trapezoid 17. trapezoid 18. rhombus 19. trapezoid 20. rhombus 21. parallelogram

Lesson 8: Pentagons, Hexagons, and Octagons

1. pentagon 2. hexagon 3. octagon 4. hexagon 5. octagon 6. pentagon 7. octagon 8. hexagon 9. pentagon 10. hexagon 11. octagon 12. pentagon 13. pentagon 14. hexagon 15. octagon 16. hexagon 17. octagon 18. pentagon 19. hexagon 20. pentagon 21. octagon

Review Exercise B

1. scalene right triangle 2. square 3. rectangle 4. equilateral triangle 5. trapezoid 6. isosceles triangle 7. rhombus 8. scalene triangle 9. parallelogram 10. rectangle 11. isosceles right triangle 12. rhombus 13. trapezoid 14. scalene right triangle 15. isosceles triangle 16. parallelogram 17. scalene triangle 18. square 19. isosceles triangle 20. rectangle 21. scalene right triangle

Lesson 9: Circles

1. diameter 2. radius 3. diameter 4. arc 5. two radii 6. one arc and one radius 7. one radius and one diameter 8. one diameter and one arc 9. one diameter and one radius 10. three radii 11. two radii and one diameter 12. two arcs and one diameter 13. one arc and two radii 14. two arcs and one radius 15. one diameter and two radii 16. four radii 17. two radii and one arc 18. two arcs and one diameter 19. one arc, one diameter, and two radii 20. four radii 21. four arcs

Lesson 10: Chords, Segments, Sectors, and Semicircles

1. segment 2. segment 3. semicircle 4. sector 5. segment 6. semicircle 7. sector 8. sector 9. segment 10. two segments 11. one segment and one semicircle 12. one sector and one segment 13. two segments 14. two sectors 15. one sector and one semicircle 16. one semicircle and one segment 17. two semicircles 18. two sectors and one segment 19. four sectors 20. three segments 21. one semicircle, one segment, and one sector

Lesson 11: Inscribed Polygons, Tangent Lines, and Circumscribed Polygons

1. inscribed rectangle 2. circumscribed isosceles triangle 3. inscribed right triangle 4. inscribed hexagon 5. circumscribed square 6. inscribed isosceles triangle 7. inscribed pentagon 8. inscribed square 9. inscribed octagon 10. circumscribed trapezoid 11. inscribed trapezoid 12. circumscribed rhombus 13. inscribed hexagon 14. two inscribed scalene triangles 15. inscribed pentagon 16. circumscribed pentagon 17. inscribed octagon 18. circumscribed hexagon 19. two inscribed trapezoids 20. two inscribed isosceles triangles and one inscribed rectangle 21. circumscribed octagon

Lesson 12: Congruent Polygons, Diagonals, and Complex Figures

1. rectangle: two congruent scalene right triangles 2. square: two congruent rectangles 3. isosceles right triangle: two congruent isosceles right triangles 4. hexagon: two congruent trapezoids 5. equilateral triangle: two congruent scalene right triangles 6. pentagon: one isosceles triangle, one trapezoid 7. trapezoid: two trapezoids 8. isosceles triangle: trapezoid, isosceles triangle 9. square: two congruent isosceles right triangles 10. rectangle: square, rectangle 11. parallelogram: two congruent scalene triangles 12. rectangle: three congruent rectangles 13. equilateral triangle: two trapezoids, equilateral triangle 14. parallelogram: isosceles triangle, trapezoid 15. pentagon: two congruent isosceles triangles, one isosceles triangle 16. octagon: two congruent trapezoids, one rectangle 17. square: two congruent scalene right triangles, one isosceles triangle 18. hexagon: two congruent isosceles triangles, one rectangle 19. parallelogram: two congruent isosceles triangles, one parallelogram 20. square: two congruent isosceles right triangles, one isosceles right triangle 21. octagon: two congruent isosceles triangles, one hexagon

Review Exercise C

1. hypotenuse 2. diagonal 3. radius 4. diagonal 5. arc 6. diameter 7. diagonal 8. tangent 9. hypotenuse 10. one radius and one arc 11. tangent 12. diagonal, hypotenuse 13. one radius and one chord 14. one chord and one arc 15. one chord and one arc 16. one chord and one arc 17. diagonal, hypotenuse 18. tangent 19. one tangent and one diameter 20. tangent 21. diameter, hypotenuse, diagonal

Final Comprehension Exercise

1. triangle 2. circumference 3. octagon 4. radius 5. obtuse 6. hypotenuse 7. quadrilateral 8. chord 9. diameter 10. perpendicular 11. rectangle 12. square 13. hexagon 14. vertex 15. isosceles 16. parallelogram 17. semicircle 18. scalene 19. acute 20. arc 21. parallel 22. trapezoid 23. equilateral 24. pentagon 25. congruent 26. tangent 27. polygon 28. inscribed 29. sector 30. rhombus 31. circumscribed 32. segment

ABOUT
THE START SMART BOOKS

They cover a wide range of subjects in language arts and mathematics.

They encourage students to learn by making the subject itself enjoyable, rather than "sugar-coating" it with cartoon drawings, coloring pictures, or other irrelevant material.

They require students to think with discipline and logic.

They give elementary school students a solid head-start by introducing them to subjects and concepts usually postponed until high school.

They are practical workbooks, each of which contains hundreds of problem-solving exercises.

They can be adapted for students at various grade levels.

They teach students new vocabulary, increase their attention span, and hone their test-taking skills.

OTHER TITLES IN
THE START SMART BOOKS

Word Games to Learn by: Distinctions
Word Games to Learn by: Verbal Correspondences
Word Games to Learn by: Categories
Thinking with Words
Vocabulary Building: Prefixes and Suffixes